SPUMS JOURNAL

South Pacific Underwater Medicine Society

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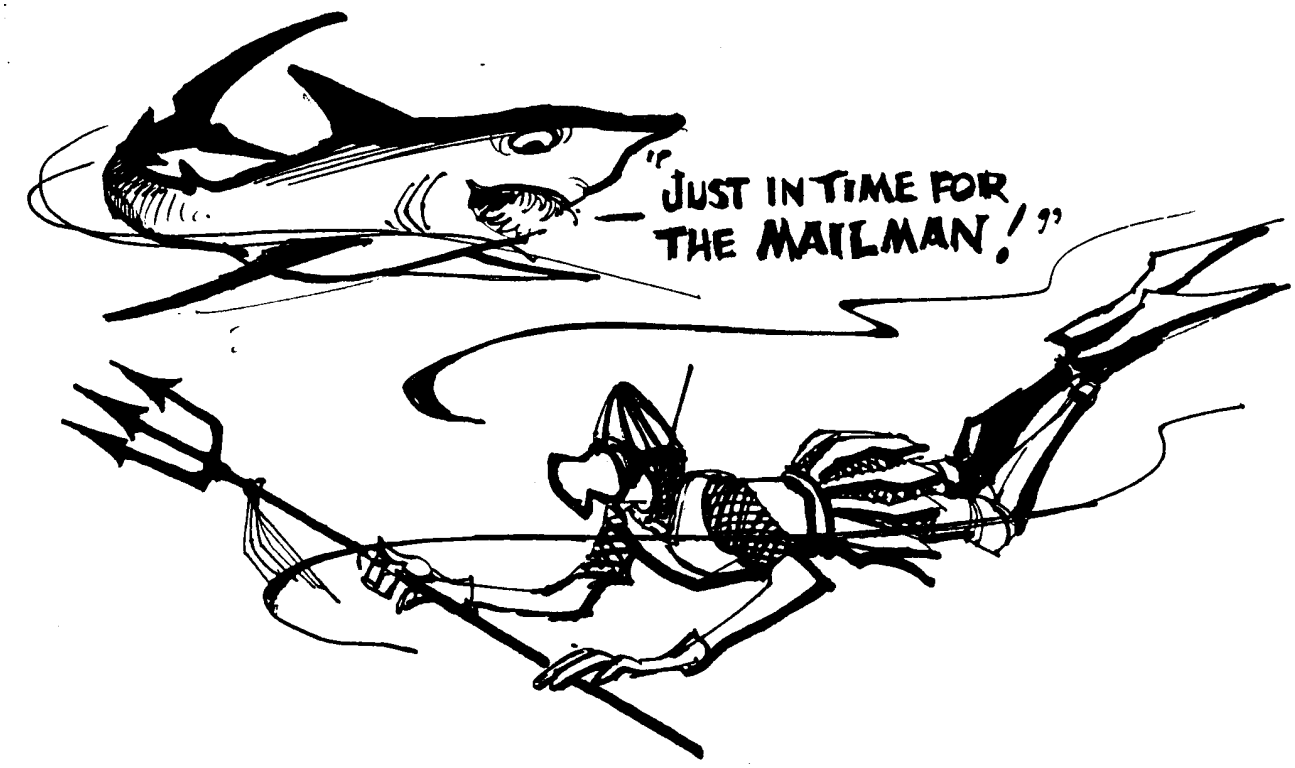

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OFFICE BEARERS

EDITORIAL

Ask almost any person you meet what they know about diving problems and they will mention Decompression Sickness and Sharks. These are certainly matters of importance to divers, but the former is one danger most sport divers should be able to avoid by planning their dives correctly and the latter is fortunately an extremely rare cause of morbidity. Surprisingly, perhaps, there still remains much that is not understood about both these matters. Decompression sickness, which only ejected Air Embolism from its embrace in the early 1930's, has become so thoroughly researched that now no really informed person can state with certainty where the pathological basis of the symptoms is located. Lucky is the newly qualified diver, who is probably certain that the bubbles are where the symptoms are experienced. It is indeed good to have the benefit of Dr David Elliot's experience in these matters, for diagnosis is only easy in the edited case presentations which reach the text books.

In his usual insensitive manner, Man has carried into the marine world his superiority complex vis a vis other creatures, tending to treat them as food, pets or a darned nuisance to be hunted down and possibly eliminated. In recent years the ecological importance of creatures labelled as "vermin" has been increasingly accepted by those not immediately subject to their depredations. This process has now even come to effect our attitude to sharks, though the approved relationship could be ruined by a few careless or hungry sharks. Nowadays even underwater photographers have realised the market for gung ho! bangsticking of sleepy sharks is no longer there. The audience has even grown weary of looking vicariously out of shark cages and the search is on for fresh thrills. Whether stirring sharks into a feeding frenzy and then seeing whether they can bite through chain mail advances our understanding of shark behaviour, or of the survival of sailors and airmen in shark infested waters, is debatable. However the most obvious motivation is the desire to titillate the jaded senses of the great paying TV audience, and soon someone will get damaged in a bid to outdo the opposition. Some may remember back to the pre-war days when adventurous cameramen toured the African bush seeking pictures of charging rhino and of natives hunting lions. People got killed (as well as the animals) and were filmed being killed. Hopefully the underwater world will be spared such an unwelcome development of risk taking.

Standards of Medical Fitness for Diving are not identical, as can be seen by comparing the information from different countries. Undoubtedly the standards are applied with very varying strictness even within each country or even totally ignored. There is general agreement concerning the major prohibiting disabilities but assessment of the diver rather than the condition seems accepted in many instances. The BS-AC has apparently become less rigid in its attitude to diabetes recently, though the remarkable litigation they suffered must have made such a decision extremely difficult. We are pleased to publish a report of this case, which has much of importance in it for both doctors and instructors. The need for ECG as a routine is, like the routine FBC, less required for sport divers than is an audiogram or a vitalograph record. As has been asked previously, how deeply should we investigate as a routine? The French (CMAS) seem to think that they alone are taking action in the matter of medical fitness, which rather ignores the efforts of their UK neighbours and the information sent from Australia, to mention but two sources. The UK Department of Energy Guidelines for their Approved Doctors are admirable and very similar to the advice given by our President (ref: Correspondence, SPUMS Journal July-September 1981). The concept of a list of Approved Doctors to undertake diving medical assessment is one which may well develop de facto as a result of instructor choice in Australia. The production of such a list by SPUMS could run into problems with assessment of doctor's diving medical understanding, at least until the RAN can provide more courses at the School of Underwater Medicine.

The publication of the Supplement has been an intense task and all those involved deserve congratulations on their achievement. The publication of the mortality report for 1980 has similarly had a long gestation but it is hoped will be of interest to readers. It is a preventative medicine project intended to keep its readers from becoming subjects in future years. The price of safety, like liberty, is eternal vigilance.

All readers are wished Seasonal Greetings and interesting (but safe!) diving in 1982. Our apologies are extended to Dr David Elliott for any errors that have crept in during the transformation from tape recording to printed word.

The postal strike caught the Editorial and then the Christmas holidays delayed the printing of this issue.

SHARKS DO NOT LIKE COLD STEEL

For many years Rod and Valerie Taylor had few serious rivals in the business of taking pictures of sharks, but the film JAWS changed all that. Everyone wanted to get into the act and show closer close-ups of jaws just about to devour the brave divers. There was no longer an admiring public for pictures of power-heads going THUMP and sharks seen littering the sea floor. It had also become apparent that though sharks could be hard to attract to the camera area, even using barrels of blood and offal, once a state of feeding frenzy was achieved the term "inedible" lost all meaning. Cages were found useful, but they restricted the diver's mobility and the public soon became blase and ceased to be impressed by the attempts of the sharks to get at the divers. The public likes to know that the performer may really get chewed up and the bars looked good and strong.

Despite much investigatory work, the USN had been unable to come up with any worthwhile shark repellant. Wearing a black plastic bag might save poor sailors but did not help the image of being fearless that shark photographers need to have. Though the Moses Sole is repellant to sharks, divers lack the glands necessary to secrete the short acting chemical they produce. Then Ron had an idea. He had seen mail boning gloves, used to protect butchers, and decided to have a chain mail suit made to wear while diving. The suit, weighing 6 kg, was flexible but naturally lacked the stretch of a wet suit, so Valerie got the honour of first wearing the suit, of being the first "live bait" to test its effectiveness.

The first dives, at Moore Reef, were less successful than expected, the sharks refusing to make deliberate attacks even during feeding frenzy. The suit protected from brushing contact from the sharks, but this was not the kind of picture desired. Later, in January 1980, they were joined by their project colleague Jeremiah Sullivan. He was from Scripps University and a trifle more cautious than Rod, winding strips of heavy fibreglass round his arms before pulling on the mail suit. This was to protect should any links break and teeth seek to penetrate the subject (himself). This was correct forward thinking! They were at Seal Rocks intent on making a nuisance of themselves in a cave containing several grey nurse sharks. The sharks left in face of such aggressive behaviour, though two wobbygongs remained. After spitting out some fish covered by a piece of the mail one wobbygong decided to ignore the intruders. A smaller wobbygong was annoyed by having a mail clad arm pushed at him repeatedly. Ultimately he too decided he had had enough, and took a nibble at Ron's elbow as he left, having noticed that this diver had no mail protection. This incident possibly tells us something of the difference between Homo Sapiens and lowly fish. Some days later a co-operative wobbygong was found who bit Jeremiah's protected arm without damage to either party. Now they felt confident that they could test in real danger conditions and decided to visit San Diego where the oceanic blue sharks, known to attack man and be fearless of divers, roam the deep waters.

A small blue shark was caught and placed on the deck. It refused to bite Jermiah's mail clad arm by choice, only obliging when the arm was forced into its mouth. All survived this test, the shark being rewarded by a return to the sea. Jeremiah then entered the ocean with a supply of fish. He noticed that he was most attacked when floating on the surface, attention being concentrated on his upper limbs (holding the fish), his legs being left alone if he kept them moving. These sharks seemed to keep away if he seemed to be aggressive towards them rather than passive. They also seemed to be attracted to the orange wet suits of Rod and Valerie, who were taking photos of Jeremiah in the metal suit. He was able to trick the sharks into grabbing and chewing his hand by withdrawing the fish he had been offering when the shark was fully committed to its attack on the bait. Despite vigorous chewing and dragging of his hand, it remained undamaged. It was apparent that the sharks were not interested in taking a bite of the mail, only doing so when foiled in attempts to seize the bait fish.

These experimental dives required considerable and sustained personal courage and a total faith in the mail's protective qualities. On one occasion events nearly ended in favour of the sharks, for one of the larger sharks approached from above and grabbed Valerie by the head, then shook to try to cut free what he was holding. The shark, luckily, soon released Valerie. She was soon distracted from her sore neck as other sharks chewed her arms. It was suspected that some sharks learnt from their encounters and thereafter stayed at a distance despite the offer of fish.

In late 1980 they returned to the Barrier Reef. In an attempt to maximise the shark interest on the arms, fish were placed under the mail and tied about the shoulders. Grey reef sharks appeared from the deep water and then some white tips over the reef shallows. Suddenly a small white tip rushed forward and got a good grip of one arm and started to spin round to tear out a portion of flesh. When this failed, the shark slowed, then let go. It made no further attack but remained nearby thereafter. A larger white tip now came, doubtless excited by the former shark's activities. It grabbed an arm and chewed, fish particles being forced out through the interstices of the mail as a result. Valetie came to the conclusion that unless the bottom, holding teeth obtained a good penetration, the shark will not start to spin but contents itself with a thorough chew. It would be inadvisable to dive with any weak or damaged links in the mail.

On one subsequent occasion a shark frenzy melee was entered and one shark grabbed Valerie's face, dislodging her mask and regulator and tumbling her in a snapping "dog fight" situation. Luckily Ron was nearby filming the events, so able to assist. The mail had saved her life, but without its protection she would never have placed herself in such a dangerous situation.

Caution prevailed when the great white sharks were involved because they were capable of crushing the diver and swimming off with the remains. It would be little comfort to have a good report on the suit of mail in such circumstances. They therefore made a dummy and dressed it in the mail. A "Great White" made aggressive attacks which the suit survived though any diver would have been killed.

It would appear that most sharks dislike the steel suit, possibly because of electrical fields, but the Great White shark is actively annoyed by such suits. Once again a remedy has failed to repulse all sharks. But as the most likely attackers are discouraged, some light survival gear which produced an electric field might be affective. Unfortunately the use of an orange colour to increase the sighting of survivors in the water tends to attract sharks also. It is noteworthy that, when not stirred into a feeding frenzy, sharks choose to avoid people giving "I'm well and active" signals.

Some explanation of the sharks' behaviour comas from the work of Dr Adranus Kalmijn at Woods Hole Oceanographic Institute. She has shown that the electroreceptors on the head of a dogfish can detect an electric field of less than five thousandths of a microvolt per centimetre. This sense enables detection of prey hidden beneath the sand. To creatures as sensitive as this, Rod, Valerie and Jeremiah must have seemed like Hi-Fi enthusiasts with their woofers and tweeters at full volume. Only the Great White really showed his feelings openly about such unwelcome visitors.

LETTERS TO THE EDITOR

The Editor,

It has been pointed out to me that part of my letter to Mr Denny, printed on page 28 of the July to September 1981 issue of the Journal could imply that medical benefits are payable for diving medicals.

This is not so. The relevant section of the Medical Benefits Schedule Book, Amendment dated 1 September, 1981, is Section 1, Part B, paragraph 27, which is headed "Health Screening". This debars "multiphasic health screening; programs for testing fitness to undertake physical training courses, sport, vocational activities; examination and diagnostic tests for driving, flying, and other licences, entrance to schools and other educational facilities, for travel requirements and for the purpose of legal proceedings;" from benefits.

I used the item numbers in the example to link the services with Government recommended fees.

Yours sincerely,
John Knight

THE 5PM GAME

David Elliott

You are on holiday in a peaceful fishing village on the Atlantic coast of Cornwall when a local doctor tells you that he has a radio message that there has been a serious diving accident on a sparsely inhabited island some miles away. He does not know the full details, but apparently there is one unconscious diver and no recompression chamber. There is a fishing boat ready to take you both to that island, but there is only a few minutes left before the falling tide will prevent its departure. It is not fine weather, so you may not be able to get the patient back to the local emergency room for about twelve hours. The local doctor drives you down to the harbour via his well-equipped dispensary. It is a six hour journey out and a six hour journey back, at the very best, so the chance of getting any support out there is pretty negligible. There is no radio communication available.

I want each one of you to write down, in order of priority, the first fifteen items you would want to take with you, as there may not be time to grab everything.

Here is a list of some twenty or so items which were almost all in the final lists of four groups of people associated with commercial diving, who did the same game a month ago. There was one item which I considered quite important that no group put forward and I will be very interested to see if you do the same. The items are not in order of importance. They have been very carefully randomised. An intravenous giving set, sterile pack, complete; A Doppler Bubble Detector, complete; A battery operated ECG Machine; A patella hammer and tuning fork; A sterile pack complete of miscellaneous catheters; Heparin for injection; Trocar and cannula; Heimleich valve pack, sterile, complete; US Navy diving manual; Four litres of normal saline and one of Dextran; Various airways, an Ambu bag or its equivalent; a lumbar puncture set, sterile, complete; An auroscope cum ophthalmoscope; Low reading mercury thermometer; Cortico-steroid for injection; A space blanket with respiratory heat exchanger; An anaeroid sphygmomanometer with stethoscope; Note paper and pencil; Assorted needles and syringes, sterile pack; An oxygen cylinder and regulator, complete; A portable suction unit; A laryngoscope, with endotracheal tube or an oesophageal obturator airway; Urine testing kit. The only other item on the list is analgesics, unspecified.

Now, believe it or not, that covers all the options of the previous four groups of doctors, all of whom had some experience in diving medicine. The surprising thing is the lack of medication in that list. You are perfectly free to add additional items of your own to that list if what you have put down is not included. It does not mean that you are wrong, you may well be right.

Now, in groups of five, pare the list down to what you all agree are the first ten things to take. I hope you will find that the various groups have got some measure of agreement.

PROVISIONAL REPORT ON AUSTRALIAN DIVING RELATED DEATHS, 1980

Douglas Walker

SUMMARY

Four (4) deaths were identified where the victim was either using a snorkel or was breathhold diving, two cases being the result of surfacing in the path of motor boats. Of the other two, one was a poor swimmer who was inexperienced in the use of a snorkel. He apparently lost his equipment while on the surface a little out of his depth and either attempted to recover it or immediately started to flounder about at the surface. He sank and drowned before nearby people realised that he was in difficulties, his shouts not being recognised as calls for help. The remaining deaths occurred when an inexperienced skin diver was so keen to try out his new, first wet suit that he entered the rough sea alone. This was probably the first time he had dived in open water off rocks. It is presumed that he drowned from surface difficulties in the white water zone around off-shore rocks.

Five (5) scuba diving deaths have been identified and another one is thought to have occurred. In every case the victim was very inexperienced and in four the incident occurred at the surface, the exception being at 30 feet depth. Buoyancy vest problems were highly significant in three cases, while two victims were without vests. In one incident an apparently tightly organised class dive ended tragically through a sequence of circumstances: the group became split and each instructor thought the victim and partner was with the other, a strong current was encountered and separated the three groups, and the victim and buddy failed to operate their buoyancy vests correctly despite a pre-dive inflation check by every pupil. They also failed to drop weight belts or immediately use their scuba air at the surface. Rough water compounded their difficulties. One fatality occurred because the recently certificated diver lacked the self confidence to undertake a surface snorkel swim of 70m, failed to drop weight belt or inflate the buoyancy vest, didn't realise that some air still remained in the tank, and got carried by current into dangerous water. One very inexperienced, part-trained diver had no CO_2 cylinder in his vest and was not sought for after separation from his experienced buddy in a thick kelp area: he was not, in fact, entangled but seems to have drowned through some minor misadventure.

It is clear that inexperience is the single most important critical factor in fatal incidents and that confidence with buoyancy vest inflation, weight belt ditching and the use of snorkel in diving conditions may be vital for survival.

CASE REPORTS

Because of the difficulties experienced in identifying cases and in deciding on a fair assessment of what actually occurred the following case reports should be regarded as illustrating the probable critical factors rather than being the total details of every fatality which occurred in 1980. The inclusion of those using a snorkel at the surface may appear to be an unfair application of the title "diving related" but the intent of the report is to improve awareness of factors influencing safety rather than to manufacture low statistics, and the snorkel should be regarded as an important piece of equipment, the correct use of which requires training. Factors which are thought to have contributed to the death appear in italics at the end of each case report.

Case Snorkel 80/1

This 18 year old inexperienced skin diver purchased his first wet suit a few days before going on a camping trip with several friends. He was keen to try it out so walked along the nearby beach, with a friend, until he came to what seemed to him to be a suitable place to enter the sea, a rocky area. He swam out and his friend saw that he was being pushed about a little by the swell so tried to signal to him to indicate a safe exiting area, but this action may have gone unseen by the victim. The swimmer was seen passing behind a large rock about 25 feet from the shore in disturbed water. The friend then lost sight of him despite moving to another vantage point, became alarmed and called the Police. When they arrived they enlisted the aid of a couple of nearby skindivers, who searched the area where the victim had last been seen. They soon found the body on the sea floor the 12lb. weight belt still on. This is believed to have been his first open water dive from rocks and he misjudged the power of water near to rocks. *(ALONE. INEXPERIENCED. NO VEST. WATER POWER)*

Case Snorkel 80/2

The victim, aged 28, was with his wife and two children in an area frequented by others. While his wife was choosing a place on the river bank near a shallow area, he was swimming on the surface with mask, snorkel and fins. He wore only swim trunks as the water was not cold. The river was tidal and it was near full ebb tide, the water being calm and with little or no current apparent. Small children were amongst those in the water near to him. Two young girls saw him floating on the surface looking down through his mask and a little later they observed him thrashing about and shouting something which they were unable to make out. He seemed to be without his equipment at this time and to be disappearing beneath the surface from time to time, though it is unknown whether he was trying to retrieve his equipment or in panic loss of buoyancy. When he failed to resurface, the girls became alarmed. Less than a minute later they found him floating on the river bed in about three feet of water, carried there by the water movement. They had to summon help before he could be raised and brought ashore. Resuscitation was unsuccessful. The maximum water depth in the river was 9 feet.
(ALONE. VERY POOR SWIMMER. INEXPERIENCED WITH SNORKEL. OUT OF HIS DEPTH)

Case Snorkel 80/3

While two friends remained in the dive boat,

two spearfisherman entered the water. They had a float with a "Diver Down" flag about 20m from their boat but were not diving near it. They soon separated, one remaining about 60m away and the other (the victim) about 400m distant. This diver, aged 29, chose to spearfish in an off-shore channel used by speedboats travelling in this area. People in a boat using this route felt a bump, saw blood in the water, made an unsuccessful search for the shark or porpoise they assumed that they had hit, and then proceeded to their destination, where the propeller was taken for straightening. When the boat owner heard that a diver was missing in the area he had recently passed, he realised with horror what had happened. It would have been impossible for them to avoid this tragedy as they had no reason to expect a skindiver to surface in their immediate path. The victim, when recovered, was seen to have suffered immediately fatal injuries.
(ALONE. NO DIVING FLAG. IN BOAT CHANNEL. PROPELLER INJURY)

Case Snorkel 80/4

Family groups were picnicking on the river bank about 350 yards from the river's mouth. A number of power boats were drawn up on the bank about 50 yards downstream. The victim, a boy aged 15, was using a snorkel and diving in the nearest deeper water (12 feet) about 30 feet from the bank while one of his sisters was in the water nearer the bank. His father saw the girl tossed about by the wave from the power boat which came upstream rapidly as near to the bank as the deeper water allowed, and as he rescued her he became aware that the boat had hit someone further out in the river. He suddenly realised that the victim was his own son and rushed to attempt to rescue him. Unfortunately the injuries received were immediately fatal. A fisherman on the river bank saw the boy on the surface in the boat's path, but the driver of the boat failed to see him at any time. The boat was said to have been travelling too fast for the river conditions and the look-out may have been inadequate in the circumstances of there being swimmers in the water off the picnic area, and the choice of the course near to the bank inadvisable, but there were ripples on the water and the driver was facing into the sun so it would have been difficult to see a swimmer in the water straight ahead. There was no float or flag to give warning.
(ALONE. NO FLAG. BOAT AREA. PROPELLER INJURY)

Case Scuba 80/1

A number of divers proceeded in two aluminium boats to a noted diving area, some rocks a little distance off shore. The first boat carried four scuba divers, the second had three occupants. Two were spearfishers and therefore presumed to be breathhold divers, the third being the victim with his scuba equipment. They anchored, between 20 and 40m apart, in good diving conditions. The victim was a large man who is said to have been a heavy smoker. He had received no scuba training and had no medical check, was aged 32 and was making his 3rd or 4th dive. He wore T-shirt, jeans, mask, fins, weight belt and scuba tank with a regulator. He had neither buoyancy vest nor snorkel. After entering the water he appeared to have some minor surface problem through entanglement with one of the spearlines but freed himself and started to swim towards the other boat on the surface while his two companions went off in another direction.

At this time two of the divers in the other boat had descended while two were completing their preparation as they awaited the arrival of the victim. He was seen to start free style swimming, apparently without equipment and then to experience some problem, but he did not call out so no immediate action was taken. One scuba diver in the boat thought that his assistance might be required and said so to his companion in the boat. He then entered the water and descended to advise the other two scuba divers to wait where they were while he proceeded underwater towards the other boat. He came across the victim on the sea bed, here about 55 feet deep, minus equipment. He inflated his own buoyancy vest and surfaced the victim. It was difficult to get the body into the boat because of its weight. Resuscitation was unavailing. It is not clear why such an indirect response to a presumed need for assistance was chosen. There is no information concerning the ownership of the tank (which was borrowed) or whether it was turned on and no reason is apparent for the victim first ditching the equipment and then drowning in relatively calm water at the surface. Possibly he was overweighted and swallowed water, having no snorkel and apparently not thinking to use his scuba regulator for the surface swim.
(UNTRAINED. INEXPERIENCED. ALONE. SURFACE SWIM PROBLEM. NO SNORKEL. NO BUOYANCY VEST. SCUBA EQUIPMENT DROPPED. DIFFICULTY IN GETTING VICTIM INTO BOAT. BORROWED TANK.)

Case Scuba 80/2

A group of five divers had been together at 65 feet for 15 minutes when one of them accidentally dropped his weight belt and started an undesired ascent, his problem aggravated by the fact that he had inflated his buoyancy vest to adjust his buoyancy at depth. His buddy ascended with him and the others soon followed. It was decided that all would return to the shore, two going with this diver and the remaining two following in the rear. It was the victim-to-be and buddy who were the rear party. The buddy suggested that an underwater return would be best but was told that all air had been used. The suggestion that a snorkel surface swim must be undertaken to cover the estimated 70m to shore was greeted with horror as being too far. The water was somewhat choppy and a surface current was encountered so it was decided to go with the current rather than trying to cross its flow. Unfortunately this led them into even rougher water conditions, where they were hit by several large waves in succession. The buddy attempted without success to drop the victim's weight belt. He did not think to activate the buoyancy vest, as having none himself, he never thought about such an aid. The victim had not worn this vest previously: it was a type capable of either oral or tank feed inflation. Subsequent tests revealed that the tank still contained 450 psi

air. The victim lost consciousness and the buddy was lucky to attract the notice of some surfboard riders, who assisted bringing the victim ashore. Resuscitation had a limited success, the victim reaching hospital. Death occurred a week later from the pulmonary and cerebral damage which had occurred. This was the third dive made by the victim, age 22, since the recent completion of a scuba diving course.
(NEWLY CERTIFICATED. INEXPERIENCED. LACKED SNORKEL CONFIDENCE. CURRENT. ROUGH WATER. FAILED TO DROP WEIGHT BELT. FAILED TO INFLATE BUOYANCY VEST. BUDDY ASSISTANCE. DELAYED DEATH).

Case Scuba 80/3

This man, age 23, was an interstate visitor. His friend, a certificated scuba diver, hired scuba equipment for them both. The visitor had been learning to scuba dive for the past seven months but this was only his second open water scuba dive, the first such dive being on the previous day. They snorkelled on the surface from the beach the short distance to the rocky coast area and then dived. After viewing an underwater cave they became aware of a current and decided to return to the beach, but unfortunately soon became separated. The buddy therefore surfaced and looked around for his friend, who he saw on the surface nearer to the rocks than he was, with mask in hand and nose bleeding. His regulator was out and not retained even when the buddy replaced it. He advised the victim to retain his weight belt, lest he become too buoyant and get washed onto the rocks, and started to tow him. At one stage the victim seemed to be attempting to use his regulator and at some stage the weight belt and backpack were ditched, though it is not certain when or by whom. Rough water made exiting onto the rocks difficult. Resuscitation was unsuccessful. The victim who was not wearing a wet suit, had an 18lb weight belt.
(PART-TRAINED. INEXPERIENCED. SURFACE DIFFICULTY. ROUGH WATER NEAR ROCKS. CURRENT. EXITING DIFFICULTY. BUDDY ASSISTANCE. HIRED EQUIPMENT)

Case Scuba 80/4

There are many reasons for diving and the search for abalone seems to have been important to divers in this area. The victim was part-way through a reputable diving course, during which he had dived in kelp and survived its entangling properties without panic while collecting abalone, and on this occasion he was with a highly experienced diver on a abalone hunt. They were in a kelp area, snorkelling till they came to a deeper area which they judged was more likely to provide better hunting. The buddy noted a loss of contact with the victim but immediately afterwards suffered cramp and was forced to ascend, inflating his vest (CO_2 cylinder functioned correctly) and dropping some of his abalone. He managed to attract the attention of some friends on the shore and a dinghy was dispatched to collect him. They had been underwater only 20 minutes so he knew his companion would have sufficient air remaining for safety and it was not till he had been ashore for 15 minutes or so that he became worried and initiated a boat search for signs of the missing diver. The Police were alerted but darkness had fallen by the time they arrived. In the morning the body was recovered from the sea floor. It was lying at the base of some kelp but was not entangled. Water depth was 30 feet and all the equipment was still in place. The contents gauge indicated 700 psi remaining. He was wearing a buoyancy vest but it had no CO_2 cylinder, which was known to the buddy pre-dive. The reserve lever was in the "off" position. The autopsy on this 40 year old was unusual in that a Chest X-ray was performed and the mastoid cavities were examined to exclude the possibility that barotrauma had been a factor. This is not universally considered at autopsy investigation of diving-related deaths.
(PART-TRAINED. INEXPERIENCE. SEPARATION. USING SCUBA. BUDDY'S CRAMP DISTRACTED ATTENTION FROM RISK OF LEAVING VICTIM ALONE. NO CO_2 CYLINDER IN VEST. HAD OWN EQUIPMENT.)

Case Scuba 80/5

Although this diver had completed the usual course, certification had been withheld, by mutual assent, until greater facility with mask clearing had been demonstrated. The victim, age 20, was therefore with a class dive, intending to mask-clear at 20m as the final test. There were eight pupils, the chief Instructor and an Instructor-in-training. The dive was carefully organised, with a pre-dive description of the dive plan, the ABC check of each pupil, individual oral inflation of all vests and then individual water entry, the instructor awaiting them in the water outside the surf zone and his assistant bringing up the rear. There was a head count, then all deflated their vests and, one after the other, descended to the instructor waiting for them on the sea floor (10 feet depth), the assistant again following the last pupil. Visibility was about 10 feet in this place. Another head count was made. One of the pupils experienced some difficulty with ear equalisation so one of the instructors joined this diver (and buddy) while the condition was remedied. The other instructor now moved the group off a short distance, not immediately noticing the splitting of the class. However he noted the absence of his colleague and so assumed that each had four pupils. The instructor who had helped the diver with the ear problem was unable to find the remainder of the party when he again reached the sea floor so ascended and surface checked. A current was apparent and the two groups were considerably separated by this time so both made their way back to shore separately. It was only several minutes after they met on land that it was apparent that two divers were missing.

During the initial descent the victim's buddy experienced difficulty from excess buoyancy because some air remained in his vest. By the time the problem had been resolved the pair were unable to see any trace of the other divers. They ascended, noticing the current both underwater and at the surface, to find themselves far from the shore

in somewhat choppy water. Both divers attempted without immediate success to inflate their vests, the victim being seen pulling on the activating cords. It is supposed that the $C0_2$ was activated but that the venting valve was simultaneously opened, the buddy himself mentioning the difficulty of trying to pull the correct cord. They found themselves being submerged by the rough conditions and became separated. The buddy now realised that his regulator could provide him with air and this gave him some confidence until it ran out. Then he remembered to use his snorkel. He also managed to orally inflate his vest to a certain extent, but was getting exhausted and in danger of drowning when reached by rescuers. They activated his vest without any difficulty and brought him back to the shore. They were unable to see any signs of the victim, whose body was only recovered four days later.

When it was realised that there were two divers missing, the divers looked out to sea and could see two divers on the surface some distance away. The two instructors and two nearby experienced divers immediately entered the water and made a surface snorkel swim towards the missing pair, attempting to keep them in sight at all times. Unfortunately one disappeared from view.

The victim was known to use less air than others so had only been given a 50 cubic feet tank. Neither of the divers apparently thought to drop their weight belt in the stress situation of the rough surface conditions. *(WELL PLANNED CLASS BUT SEPARATION OCCURRED. INEXPERIENCE. BUDDY SEPARATION THROUGH ROUGH SEA. FAILURE TO OPERATE VEST CORRECTLY. FAILURE TO DROP WEIGHT BELT. CURRENTS)*

DISCUSSION

It is worth commenting, firstly, on the extremely small number of cases identified as having occurred in Australian waters. The search was diligent and it is believed that few additional deaths will be noted later, though persons knowing of such cases are requested to notify them. The low numbers illustrate the paradox that an obviously unsafe procedure, going underwater, can be made safe through careful recognition of factors critical to survival. Even these few deaths might not have occurred had a few factors been ordered differently.

Confident use of a snorkel is a skill which must be acquired, it not being natural to breathe through the mouth with the face submerged. It is a skill which may be vital for survival, for the body usually floats at equilibrium at the surface face down and submergence occurs if the head is raised above the water surface. Experienced divers often forget that period of their lives before they regarded the snorkel as a natural airway.

There is a tendency to underestimate the power of water. Many get to believe that a wet suit, mask, snorkel, fins and (possibly) scuba give mastery of the sea. The unfortunate few never get a second chance to learn better. The value of additional buoyancy, through the dropping of weights and inflation of a vest, may be forgotten in a surface stress situation of near drowning. The wisdom of the accepted dive procedure of surfacing while still having a reserve of air is obvious at such times.

Propeller driven craft can be heard underwater for a considerable distance but cannot be accurately localised. A “Diver Down” flag, if used, may alert the craft to remain clear and provides a certain moral advantage to the diver who encounters a moving propeller, but no physical protection. It is therefore wise to avoid channels or areas frequented by such craft and to use the Diver flag as an indicator of your immediate presence while being aware of the limitations of such protection. It is possible that the danger from propeller craft is increasing. A swimmer in the water is difficult to see from such craft and someone surfacing in choppy water, particularly if made inconspicuous by a black wet suit, gives even an alert driver little chance to change course to avoid a tragic encounter.

Scuba diver deaths this year reinforce previous observations that the inexperienced are disproportionately represented in the fatal incidents. Currents and rough water were critical in four, the fifth death probably resulting from some minor misadventure (such as loss of regulator) while alone underwater. In two incidents the buddy made valiant attempts to assist the victim but was unsuccessful. The outcome could have been different had there been adequate buoyancy for the victim and had there been air remaining in the cylinders in adequate quantity.

The need for efficient-when-needed buoyancy aids is tragically apparent in these cases. Oral inflation is an impossible option in any situation which has progressed to near drowning. There are very obviously problems with the $C0_2$ type vests on occasion (increased if there is no $C0_2$ cylinder!) and it is obviously impossible to pre-test the correct function of any cylinder before its once-only use.

Murphy’s Law operated at its most unjust in the class dive fatality, every usual and reasonable care having been taken in the management of the dive. However the co-existence of imperfect visibility, strong currents and minor problems experienced by two of the pupils initiated a train of events where problem compounded problem. The delay in recognition of the loss of two members of the class would have had minor consequences but for the surface current and choppy conditions. The pupils were unable to manage these conditions despite their training and their possession of scuba air supply, buoyancy vests and droppable weight belts. Correct use of any of these diving aids would have reduced the consequences of their separation.

It is axiomatic that fatalities represent one extreme of a spectrum of endpoints, many incidents occurring which result in minor or nil morbidity. Reports of such incidents are,

regrettably, rarely available. It is hoped that reading reports on the cases which have ended fatally will enable divers, including instructors, to recognise critical factors before they can progress to an irreversible degree. It is also hoped that appreciation of the value of the reporting of incidents which have been managed successfully will grow and that more will assist diving safety through the writing of CONFIDENTIAL REPORTS on what occurred.

ACKNOWLEDGEMENTS

This report could not have been made without the ready support and assistance of the Attorney-General's and Justice (or Law) Department in each State, the co-operative response of the Police to certain enquiries and the active interest of several organisations and divers. The active interest of the Water Safety Councils of NSW and WA in collecting information about drownings has been very helpful in identifying certain cases, and the support of the AUF and of FAUI is valued. It is hoped that other organisations will take an active interest in the future, joining the list of those who recognise the value of increasing our understanding of diving problems.

PROJECT STICKYBEAK

Project Stickybeak is an on-going project seeking to document diving-related events of all types and severities. Information, all of which is treated as being CONFIDENTIAL in regard to identifying details, is utilised as appropriate for current dissemination and retained for use by future investigators who will be bound by similar 'medical confidentiality" guidelines. Any person or organisation is free to use the printed reports to increase awareness of factors effecting diving safety. Reports may be sent to:-

Dr DG Walker,
PO Box 210,
NARRABEEN NSW 2101

OCTOPUS VICTIM

A newspaper report states that a Sydney tourist at South Stradbroke Island picked up a small octopus to show it to his two nieces and it bit him on the left hand. He was taken to the nearest hospital partly paralysed and dependent on a ventilator to keep him breathing, critically ill at the time of the report. Blue ringed octopus poisoning is expected to be of a limited duration of effect but the outcome of this case is not known at the time of printing.

SHARK - MAN - PROPELLER: A TRAUMATIC MIX

In January 1981 a game fisherman hooked a 4.5 m white pointer shark at Dangerous Reef, a favourite big game fishing spot 40 km from Port Lincoln, South Australia. In order to slacken the line, the boat was put into reverse. Suddenly the shark tugged the line strongly, pulling the man and his fishing seat out of the boat. The boat continued to reverse and ran over him. He was rescued by the other person in the boat and an urgent radio call for help was broadcast. He was rapidly transported to a hospital and treated for deep cuts in his right arm. The man recovered but the shark's condition was not recorded.

FATAL COMPLICATION OF WEARING A DRY-SUIT

The death, in September 1980, of an experienced diver in a Scottish loch illustrates the cumulative effect of a number of seemingly minor errors. He was involved in an underwater excavation accompanied by a student at the National Maritime Museum. They had begun to snorkel to the site when he decided that he needed more weights. When last seen he was wearing his own variable volume dry-suit and had his scuba unit on his back but was not wearing his mask and did not have the mouthpiece in his mouth. He carried 105 lb in total (cylinder 35 lb, weight belt 25 lb, shoulder harness 35 lb and 5 lb around each ankle) and was standing in 1.5 m deep water at the edge of the channel, their planned entry site. It appears that the buddy submerged leaving him to follow, later became concerned by his failure to join up and therefore started to search for him.

The victim was found on the bottom, head down and feet up. She found it impossible to raise him and it required the combined efforts of several people to raise the body.

It was found that he had ditched his weight belt but the chest harness containing weights had not been dropped because it had been put on before the scuba harness. It is surmised that he had fallen forwards into the 3 m deep water and had been unable either to reach his mouthpiece or drop all his weights. His inability to get into an upright position, a buoyancy maintained inversion problem long known to standard "Hard Hat" divers, denied him any hope of escaping drowning.

The basic critical factors were incorrect kitting up sequence, the buddy pair system being breached even before water entry, standing in a position where water entry could occur while being unprepared for such an entry and failure to ditch the scuba backpack and so release the total weights worn. But who in his place would have managed any better?

THE BS-AC ON TRIAL

Suicide followed a diving incident. Years later the BS-AC and others appear in a lawsuit. "Diver" reports:

A unique event occurred in March this year. Two members of the BS-AC and the BS-AC itself were taken to the High Court in London in a claim for damages for negligence resulting from a dive that occurred at Plymouth in September 1973. This is the story of the events leading up to the hearing before Mr Justice Michael Davies. It is published here in the hope that something useful can be learned from a full account of the sorry business.

THE DIVE

A Regional "Dive In" was arranged by the then Regional Coach for London and the South-east, Mike Todd (now BS-AC Chairman), at Fort Bovisand in September 1973. About 50-60 divers, all Second Class or experienced Third Class, travelled to Plymouth from the South-east for a weekend of interesting boat dives. Local "fixer" for the event was Chris Mash, Regional Coach for the South-west.

One dive offered was the wreck of the WAR BUFFALO or PERSIER in Bigbury Bay. The party travelled out to the dive-site by trawler, owned and operated by a syndicate from Plymouth Sound BS-AC.

On the way out Mike Todd organised the divers into diving-groups. One of the divers was Peter French, from Margate BS-AC, who was a diabetic - "controlled diabetics" being allowed by the BS-AC to undertake training at that time.

There was a bit of "lop" on the sea during the journey and Peter French's diving partner was seasick and decided not to dive. Peter was invited to dive with Mike and Chris, who had decided to have a "jolly" together.

Told by Peter about the diabetes, both divers quizzed him. They became convinced that he was in full control and was something of an expert on his condition.

The three divers undertook a perfectly normal no-stop dive on the WAR BUFFALO - about 18 minutes at a depth of 95 feet but with most of the dive at 75 feet (this was pre-metrication). At the end of the 18 minutes, Chris Mash - the dive-leader - gave the signal to ascend and all three divers held on to each other and carried out a slow ascent to the surface where they exchanged OK signals with each other and the boat and started the short swim back to the boat.

THE INCIDENT

On the way back to the boat, Mike Todd noticed that Peter was using his arms as well as his fins and wondered why as there was little or no tide. At the boat, Peter was allowed up the boarding-ladder first.

He stood on the ladder and made no attempt to get inboard. Asked why, he said he had no strength and at that point Mike spreadeagled himself across Peter and the ladder to prevent Peter from falling backwards into the sea. The party on board hauled Peter bodily into the boat and found him to be completely unconscious. What was the matter with him? Embolism? Bend? Diabetic coma?

With a dive that was well within the no-stop time, with a slow, controlled ascent and with two other divers having done the same dive and showing no symptoms at all, it appeared that a diabetic problem was most likely. An unsuccessful attempt was made to get some sugar into the victim's mouth.

It was obvious to all on board that Peter needed expert help quickly and arrangements were made to get the boat underway. Although the skipper was himself diving, the mate was on board and there were at least two other people who could handle the boat if need be.

The two divers still down were contacted while the boat was being started, then it was found that the starter-chain for the engine had broken and a spare link could not be found. At this time a smoke canister was fired, although it appeared to be a forlorn hope as there was no sea traffic in the area and the wind was blowing the smoke virtually horizontal to the sea.

By this time the skipper was back on board and managed to find a link for the chain in the filthy bilges. He effected a repair and got the boat underway. A decision was taken to head for Stoke Beach, about 20 minutes away, for it was known that there was a telephone there and the Coastguard could be contacted to advise the party how best to proceed-put the victim ashore for an ambulance, wait for a helicopter, steam in to meet the lifeboat or whatever.

Stoke Beach does not have a harbour or jetty that the trawler could enter. As the boat approached the beach, Chris Mash volunteered to swim ashore and raise the Coastguard.

He had his fins on and was ready to jump when around the headland came the Inshore Lifeboat from Plymouth. An off-duty Coastguard had been exercising his dog on the cliffs and had seen the smoke that had been set off and had alerted the lifeboat.

Peter French was handed over to the lifeboat and was accompanied by two divers to Plymouth, one of them Chris Mash because he was the local man. The information about the dive and the diabetes was passed on to the crew on the lifeboat who radioed for an ambulance, after they had discovered that it would take too long to scramble a helicopter.

The ambulance met the lifeboat and transferred Peter, Chris and the other diver to the hospital casualty unit. By this time, Peter had regained consciousness and was himself convinced that he had suffered a hypoglycaemic attack. He announced this to the hospital Casualty Officer and asked for a sugary drink. This was provided and there appeared to be a recovery. Peter was told that he could leave as soon as he felt fit enough.

He was complaining about stiffness in his legs and pins and needles and this alerted Chris who relayed to the doctor details of the

dive and asked about possible contact with HMS DRAKE. The doctor assured Chris that all the symptoms could be attributed to the diabetes and after-effects of the coma.

Reassured, Chris returned to Bovisand to relay the information that it did not appear to be a serious problem and that Peter could be expected to return shortly. But he didn't and other members of his branch who went to the hospital saw him in a deteriorated condition - with particular stiffness in his legs.

Eventually, the doctors were persuaded to seek the advice of HMS DRAKE. Peter French was transferred there for recompression treatment some five-and-a-half hours after he had first arrived at the hospital. In spite of long recompression treatment with an RN doctor in the chamber, Peter did not make much, if any, recovery and finished up with little or no use in his legs and weakness in both arms. He also finished up with extreme and continued pain and spasms in his legs.

In October 1976, Peter French committed suicide.

THE CLAIM

Before his suicide, Peter French, through solicitors, issued a writ against Mike Todd, Chris Mash, the BS-AC and the Devon Health Authority claiming negligence. After his death, the claim was pursued by his widow.

As far as Mike Todd, Chris Mash and the BS-AC were concerned, there was considerable anxiety: some three years had elapsed before the serving of the writ and some of the paperwork had strayed. However, it was located, it was in order and the insurance company, the Norwich Union, agreed that they would provide any necessary cover.* Briefly, the claim for damages made these allegations:

That Mike Todd and Chris Mash were negligent in that they took the victim too deep and for too long and did not carry out decompression stops. They failed to get fastest possible help for the victim by using a boat whose engine broke down, by not firing a distress flare immediately, by using a vessel not equipped with a radio transmitter, by attempting to land at Stoke Beach instead of going directly back to Plymouth, by failing to impress upon the lifeboat crew the importance of taking the victim directly to HMS DRAKE and permitting him to be taken to hospital. They failed to alert the Coastguard and helicopter services that diving was taking place in Bigbury Bay and their services might be needed.

The BS-AC were accused of negligence because their rules and recommendations allowed Mike Todd and Chris Mash to do the things that were complained about.

Divers reading most of the above will, no doubt, wonder how such allegations could be made. What appear to be obvious to a diver may not be quite so obvious to a layman. Try reading the above claims as a non-diver, non sea-user and many of them start to look more reasonable.

Basically what was being put on trial was the way BS-AC divers, and other sport divers, have conducted themselves for years. It is to the considerable credit of the Norwich Union that they were going to fight the case and not "settle" in any way. This was doubly creditable in that they were no longer the insurers of BS-AC members and could have been tempted to get the thing out of the way very quickly and as cheaply as possible. Potentially a lot of money was at stake. They appointed an excellent barrister to represent the two members and the Club itself.

THE TRIAL

The action was tried at the High Court in London in March of this year and took two weeks during which time some 29 witnesses were called ("Diver", May 1981). Seven barristers were involved in the action.

As there were two main defendants, the BS-AC and the hospital authorities, tactics dictated that each party would try to lay the blame at the other's door. Therefore it was the hospital's barrister that gave the BS-AC defendants the hardest time. Imagine sitting in the court, surrounded by wigs and gowns, reporters taking down every word as witnesses were questioned on their actions of nearly seven years before. Detailed questions were asked about statements in the seventh edition of the BS-AC Diving Manual intended to be guides to divers and which barristers were interpreting as rules and regulations.

The barrister for the hospital listed 30 separate pages of the Diving Manual to which he would refer and ask questions. Luckily, Mike Todd and Chris Mash are both extremely well qualified (First Class Diver, National Instructor and Examiners) and were able to handle most of the questions competently, especially as some questions showed inadequate knowledge - the difference between a bend and an embolism, the difference between a normal and a buoyant ascent, to mention only two examples.

It did appear during the action that the barrister for the widow of the victim had decided that there was nothing to be gained from attacking the amateurs. That was left to the Hospital's barrister.

"Brownie Points" were scored as Mike Todd was being taxed for not agreeing totally with a statement in the Manual. The Judge pointed out to the disappointed barrister that Todd could do so as he was the author of several of the chapters.

The Judge did comment that the divers who gave evidence showed quite a profound knowledge of their narrow sphere and one diver, Kevin Nolan - Diving Officer of the Margate BS-AC at the time of the accident was singled out for mention eventually by the Judge as being "most reliable and careful".

Mike Todd was "grilled" in the witness box for about an hour and a half, while Chris Mash, who had been in the lifeboat and the ambulance and the hospital, was questioned for more than two hours. It was an experience that neither man wished to repeat.

**The realisation of the dramatic consequences for the BS-AC, and/or members, should an insurance company seek to evade responsibility was one of the factors that prompted the Club to incorporate as a limited liability company.*

After the two-week trial, the Judge reserved his judgment. This was delivered much later than anyone had anticipated - 17 weeks after the close of the hearing.

THE JUDGMENT

In a long and detailed judgment, the Judge rejected each and every claim against Mike Todd, Chris Mash and the BS-AC. He commented that the two men had done their utmost to get help for Peter French and that they were not to blame for any mis-diagnosis of his problem, especially since the dive was perfectly normal in all respects.

There was no requirement for boats to have radio, or for the Coastguard to be alerted in each and every case and their actions after the accident were all aimed at getting help as speedily as possible.

Chris Mash could not be blamed for allowing Peter French to be taken to a hospital rather than to HMS DRAKE as there was little that he could do about it once the ambulance crew had decided to return the victim to their casualty unit.

It was found, however, that the hospital doctors had been negligent in their treatment and diagnosis of the victim. They had treated him for hypoglycaemia without checking the blood-sugar content to confirm their diagnosis, there was no neurological examination in spite of his having been unconscious for some two hours or so, and they failed to react to the requests of accompanying divers to contact HMS DRAKE as Peter French began to deteriorate.

The Judge awarded the widow and her family some £110,000 against the Devon Hospital Authorities, who also had to pay for the legal costs of both the widow and the BS-AC.

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UNUSUAL DIVES UNDER WINCHESTER CATHEDRAL

When the Dean and Chapter of Winchester Cathedral met in January 1905 to read their architect's report on the state of the fabric, they noted his warning that despite all the good work they had done there were some jobs remaining. They acted immediately to ascertain just how much of a problem there was, for the outward leaning of the south wall of the Presbytery was reaching a dangerous degree. Investigations soon revealed something of the importance of thorough treatment of the trouble, which could be traced back nearly seven centuries. The Cathedral had been built on a flooded site, the water table rising and falling with the seasons. A test trench revealed that the thirteenth century builders had rested their structure, estimated to exert a 40 tons per square feet weight, on a timber raft. The purpose was to spread the load and to fill the gap between the foundations and the peat bed below. This was never a totally successful idea, the retrochoir beginning to sink and break away from the earlier Norman part of the structure soon after it was completed. Now, only centuries later, repairs had become essential if the Cathedral was to remain standing. New underpinning was needed urgently.

As the work was below the water table a diver was employed to perform it, after the builder had dug down to the peat and partly through it. After the diver cleared the remaining peat, the water filled the hole and he had to lay sacks of concrete to about a height of three feet as walls of the tunnel ("drift") he had dug beneath the foundations. The tunnels were up to twenty feet in length. After the concrete had set, in a few hours, the water could be pumped out and the remaining space filled with concrete bricks set in concrete. The old foundations now had a strong new support. The work took from 1906 till 1911 and during this time it was estimated that he handled 25,800 bags of concrete and 114,900 concrete blocks plus 900,000 bricks.

The diver had started his career as a diver's attendant in the Portsmouth Dockyards, aged 23. He worked his way up to become first a diver's signalman and finally a fully qualified diver. By the time the Winchester Cathedral job arose he was the chief diver for Siebe Gorman, with over 200 divers under him at work around the world. The diver's dress weighed nearly 200 pounds but nevertheless buoyancy was a problem and he had to put his feet under the rungs of the ladder and pull himself down step by step. There was nil visibility and risk of infection, for the area had been a graveyard, but nothing seemed to worry him and he enjoyed a quiet smoke of his pipe whenever he took a respite.

The diver's work attracted a lot of publicity, possibly to the chagrin of some of the Cathedral's staff responsible for raising the money required for this and other necessary work. Readers will not be surprised to learn that the original estimate for all the repairs was "not more than £3,000" but the final cost was £113,000. Some things never change! Such was the fame of the diver that by the time of the Service of Thanksgiving in 1912 he was mentioned in the sermon and, afterwards, presented to King George V.

Being a modest man, he was comforted by the thought that none of the congregation would recognise him in a frock coat rather than the familiar diving suit. In 1964 a statue of "William Walker - the diver who saved the Cathedral" was set up in the retrochoir.

EXTRACTS FROM AS 22999-1979
APPENDIX A
MEDICAL STANDARDS FOR WORKERS IN COMPRESSED AIR

INTRODUCTION

These medical standards are directed to the examination of divers engaged in professional and/or commercial operations. However, subject to the qualifying notes throughout the Appendix, the standards and tests may be used for guidance in the examination/ assessment of other divers (eg. sports divers).

Wherever possible a medical practitioner experienced in underwater and hyperbaric medicine should be consulted.
NOTE: Where the results of these tests/ examinations are doubtful, it is ESSENTIAL that a practitioner experienced in underwater and hyperbaric medicine be consulted.

AGE

The age range for diver training is between 18 and 30 to 35 years. Exceptions are usually made in specific circumstances, in both military and civilian training centres. The maximum recommended age is extended to allow physically and medically fit individuals to undergo training. Six monthly medical examinations are required for all commercial divers. For those still diving beyond the age of 40 years, annual electrocardiographic examinations are required. It is not recommended that persons over the age of 40 years take up SCUBA diving for the first time.

NOTE: Non-commercial trainees under the age of 16 years are advised to dive with a 'buddy line' connected to an older experienced diver. Children, although they may be trained in diving techniques, often do not have the physical strength or psychological stability to endure the occasional hazards of diving. Age is of limited value in success prediction, but the most satisfactory age is in the early twenties. Failure rates in training professional diving candidates below the age of 19 years make this practice commercially unprofitable.

OCCUPATION

The candidate's occupation may give some indication of physical fitness, but may also be important in increasing the relevance of diving hazards, eg. aviators, air crew or passengers in aircraft should be specifically advised of the flying restrictions imposed after diving. Sonar operators and musicians may not wish to be exposed to the otological complications of diving.

MEDICAL TREATMENT AND DRUGS

Physical treatments and medication may have an adverse effect on diving and vice versa. Any drug which influences the conscious state may also affect the susceptibility to nitrogen narcosis and oxygen toxicity, whereas others may affect the assessment of decompression sickness signs.

Examples of such therapeutic drugs which may prejudice diver safety include sedatives, tranquillizers, antidepressants, antihistamines, hypoglycaemic agents, steroids, anticonvulsants, etc. Drugs taken to prevent sea sickness will usually aggravate nitrogen narcosis at depth. Alcohol and hallucinatory drugs are absolutely contraindicated because of the effects on the diver's psychological reaction to stress and the impaired judgement. Hallucinations and illusions will be enhanced in the insecure marine environment. Alcohol and marijuana have the added disadvantage of blocking the vaso-constrictive reactions to cold, resulting in rapid hypothermic complications. Recent investigations show that many drugs act in an abnormal fashion on the body under conditions of increased pressure, and it is recommended that no diving be permitted while taking any form of drug or medication.

CARDIOVASCULAR

The existence of serious cardiovascular disease disqualifies the candidate from diving. A history of cardiovascular disease and the physical examination should make the examiner aware of this. Tolerance to physical exertion and the absence of factors predisposing to myocardial failure or infarction, are required. A resting and exercising electrocardiogram shall be performed and should not show any evidence of abnormal arrhythmias or ST depression. Blood pressure should not exceed 140 mmHg systolic and 90 mmHg diastolic. Weight should be within 20 percent of the average for age, height and build. Obesity is contraindicated because it induces an increased propensity for decompression sickness, even though it may have a beneficial effect in reducing the likelihood of hypothermia. For civilian sport diving, it is permissible to allow diving with degrees of obesity that would not normally be accepted in professional or military diving. This is achieved by imposing an added 50 percent safety margin in calculating the depth/duration dive profile, also by making an absolute depth limit of 20 m (65 feet) and not permitting any dive that requires decompression staging.

RESPIRATORY

The existence of respiratory disease disqualifies diving candidates. Divers must not only be able to tolerate severe physical exertion, which requires good respiratory reserve, but must also be able to tolerate rapid changes in lung volumes and pressures with equal compliance throughout the lung segments. Any local restrictions, fibrosis, cysts, etc. may result in pulmonary barotrauma, with a tearing of lung tissue and subsequent complications including air embolis. A history of asthma is particularly ominous, as a recurrence will result in increased pulmonary airway resistance, and also the use of adrenergic drugs. Neither are acceptable in any diving operations, sport or professional. The history of respiratory disorders is complemented by the physical examination chest X-ray and simple respiratory function tests. High pitched expiratory rhonchi, which

may only be elicited during hyperventilation, indicate airways obstructions and precludes diving. To comply with the Australian standards for divers, the vital capacity should be more than 4 litres in males, 3 litres in females, and the forced expiratory volume in 1 second must not be less than 75% of the vital capacity. Any candidate with a forced expiratory volume (1 second) below 80 percent of the forced vital capacity should be classified as suspect and the test repeated after inhalation of a bronchodilator in order to detect reversible broncho spasm. Since the introduction of these standards, there has been a dramatic drop in the incidence of pulmonary barotrauma. A more rational standard for vital capacity would be to accept a value of:

VC = (27.63 - 0.112 x age) x height in cm, for males

VC = (21.78 - 0.101 x age) x height in cm, for females and allow 20 percent below this value as the minimum standard.

Nomograms are available in reference tables.

The full plate chest radiograph must include inspiratory and expiratory films.

UPPER RESPIRATORY TRACT

Disorders of this system comprise the largest cause of occupational morbidity in divers. History of chronic or recurrent allergies or infections and evidence of these, or acute disorders of the ears, nose or throat will temporarily disqualify the diving candidate. Chronic sinusitis, allergic rhinitis, dental cavities, pharyngitis and tonsillitis, etc. will all have a detrimental effect on the diver. Sinus and nasal polyps may produce obstructions during ascents or descents, resulting in barotrauma. A deviated nasal septum may also result in abnormal nasal mucosa, influencing patency of sinus ostia and the Eustachian tube. Whenever obstruction or restriction of the upper respiratory tract airways occurs, barotrauma is likely. If infection is present, it may be spread by the movement of gases during the changes in depth and pressure. Sinus X-rays should be obtained in doubtful cases. A break in the skin or mucosal lining of gas-filled spaces (eg. by recent dental extraction, minor facial lacerations which may be covered by the face mask) is a danger in diving because they allow access of gas into the deeper body tissues, resulting in barotrauma and emphysema.

OTOLOGICAL

General

The diver must have normal external ear canals, normal middle ears, and normal inner ears. In addition he must have normally functioning Eustachian tubes and this requires a normal, healthy nose.

External Ear

a) Cerumen - the external ear should be free of cerumen. Occlusion of the external ear by cerumen may lead to vertigo or external ear barotrauma.
b) Exostosis - these should not be of such size as to occlude the external auditory meatus or to lead to occlusion by cerumen being washed into the narrowed area when swimming
c) Otitis externa - a diver is rendered unfit by the presence of acute or chronic otitis externa.

Middle Ear

a) Tympanic membrane - a healthy tympanic membrane, intact and mobile, is a prerequisite for diving. The following conditions should render the individual unfit for diving: any evidence of otitis media, however mild, a perforation of the tympanic membrane or a thin, atrophic scar or fragile tympanoplasty. Obviously, it would be unwise to submit a tympanic membrane, which had been weakened by a thin scar, to the pressure changes involved in diving. On the other hand, a healed perforation which left the tympanic membrane normal in strength and mobility would be quite acceptable. A retracted and immobile tympanic membrane is unacceptable.
b) Middle ear cavity - this should be free of fluid and be easily and well aerated. This is demonstrated during otoscopy by the appearance of the tympanic membrane and its mobility on auto-inflation.
c) Eustachian tube - this must function normally ie. auto-inflation must be accomplished without excessive force. It should be noted that the ability to auto inflate at any one time does not preclude the possibility of intermittent Eustachian tubal obstruction at another time. The function of the Eustachian tube is dependant upon normal nasal function, and this requires careful assessment. The medical examiner should correct any incorrect techniques used by the candidate to auto inflate the middle ear.

Inner Ear

a) Cochlear function - ideally, divers should have normal cochlear function, but minor changes in auditory acuity may be acceptable.

The following minimum standards of hearing for divers and compressed air workers are recommended. However, a diver may be permitted to dive with significant hearing loss provided that no vestibular malfunction exists (tested by caloric ENG) and the Eustachian tube function is normal. The diver must be made aware of the risk of further hearing loss with continued diving.

MINIMUM STANDARDS OF HEARING

Hz	500	1000	2000	4000	6000	8000
dB loss	40	35	35	45	50	50

NOTE: *It should be borne in mind that loss of cochlear function may be associated with loss of vestibular function. If the vestibular portions of* the *inner ear respond to stimuli unequally, then vertigo might result,* e*specially when* v*isual fixation is poor, as frequently*

occurs in diving. This could constitute an appreciable hazard for the individual diver. The whole question of vertigo occurring among *divers is attracting considerable attention, and much investigation is underway. Until more is known about the part which diving may play in precipitating deafness or disorientation, it seems* reasonable *and safe to expect that the hearing of the diver should be near normal, and* that *vestibular function should be equal on both sides.*

Threshold hearing for divers should be 15 dB at the frequencies of 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz, using audiometers calibrated to ISO standards. This is the level classified as 'Standard 1' in most armed forces and it would seem to be appropriate to expect this standard to be reached by individuals who wish to participate in professional diving. Nevertheless, it is an insufficient range for divers, as it does not extend to 6000 Hz and 8000 Hz, which should also be tested in both initial and annual examination.

It is appreciated that this may be thought to be too harsh a standard, but it must be pointed out that this is a 'safe' level. Some individuals may have normal ears which do not withstand stresses as well as those of other individuals, but once it has been shown that there is depression of inner ear function, an extra element of risk comes into diving. This will increase as the inner ear function deviates from normal. A diver may be permitted to dive with significant hearing loss provided that no vestibular malfunction exists (tested by caloric ENG) and the Eustachian tube function is normal. The diver must be made aware of the risk of further hearing loss with continued diving.

b) Noise as a hazard for hearing - Attention has been drawn to the noise levels experienced by divers in helmets and compression chambers, and temporary threshold shifts in the hearing of divers have been demonstrated. The possibility of noise-induced deafness resulting from exposure to loud noise should be borne in mind, and all divers should have an annual audiogram as part of a hearing conservation program. The permissible duration of exposure to loud noise of different intensities is well documented and should be adhered to when exposing workers to such noise. Reference should be made to AS 1269.

c) Vestibular function - It has been shown that vertigo can be induced by pressure changes affecting the right or left vestibular apparatus in an unequal manner following cold water entering one ear but not the other ear, owing to the latter's external auditory meatus being occluded by cerumen. Similarly, vertigo can be expected to occur when diving if one labyrinth is not functioning, and the other ear is stimulated by the caloric effect of cold water in the normal ear.
The significance or importance of less marked changes in vestibular function is not fully understood as far as diving is concerned, but there is ample evidence to suggest that abnormal vestibular function will play a part in disorientation. It may prove to be wise in the future to exclude from diving those individuals whose vestibular function is not perfectly normal and equal on each side. In the meantime, it is safe to say that a diver should have normal inner ear function, in both cochlear and vestibular divisions. Testing by positional and caloric electronystagmography (ENG) should be performed if any doubt as to vestibular function exists, or where hearing loss is greater than provided by this standard.

VISUAL

Good vision is needed both underwater, to avoid dangerous situations, and after surfacing, when the diver may have to identify landmarks, floats, boats, etc. The problems resulting from an incorrect visual bearing are obvious. The use of corrected lens in the face mask is of value in reducing this danger, but the technique of buddy diving (diving while attached by a line to a visually fit diver) is even more important. Distant vision should not be less than 6/18 (corrected) both eyes or 6/24 (corrected) for the worst eye. Hypermetropia should not exceed 5.0 dioptres, but colour vision, unless grossly abnormal or required for ship's watch keeping duties, is not of great importance.

NEUROLOGICAL

Any neurological abnormality will add danger to the diver, as well as complicating the various neurological disorders due to diving, such as cerebral or spinal decompression sickness, air embolism from pulmonary barotrauma, oxygen toxicity etc. Migraine is often exacerbated by diving. Sleepwalking is of importance when a diver intends to live on board the diving boats. Epilepsy and epileptogenic drugs are contraindicated in diving. The Sharpened Rhomberg test is an excellent objective and quantifiable test to detect cerebellar, proprioceptive, motor and higher cerebral disturbances.

Freedom from psychiatric disorders is also of importance. There should be no increased susceptibility to neuroticism, anxiety states, depression, claustrophobia or agoraphobia, psychoses, or any organic cerebral syndrome.

GENERAL

The presence of severe gastro-intestinal, renal, endocrine and systemic diseases has the same harmful sequelae as neurological disorders - making the diver a potential invalid in an environment that does not lend itself to first aid or medical support. Diabetes Mellitus is a definite contraindication to diving.

Hernia may cause problems with the variation in gas volumes during changes of depth, as well as reflecting poorly on the diver's physical capabilities.

Musculoskeletal problem of any severity will limit the diver's physical capabilities, and complicate decompression sickness assessment. For divers who are employed professionally, or who undergo many decompressions, or any recompression treatments, or who are exposed to experimental diving, annual long bone X-rays for dysbaric osteonecrosis are indicated. Long bone X-ray shall be conducted prior to taking up professional diving, in accordance with the procedures specified below.

Motion sickness is dangerous to have if any diving from boats or in rough water is contemplated. Vomiting underwater is a problem especially if the diver vomits into his diving equipment or air supply. The psychological manifestations of motion sickness may also result in injudicious decisions eg. to return without completing adequate decompression stops.

Smoking of cigarettes is detrimental, not only because of its effects on general health, but also because of its specific effect on respiratory and cardiac fitness.

Pregnancy is a contraindication to diving. This is based more on the woman's systemic physiological reactions to pregnancy (vomiting with morning sickness, reduced tolerance to exertion, reduction in respiratory function measurement, etc.) than the specific obstetric complications. She may experience difficulty with clothing, harness and equipment fitting, together with abdominal pressure gradients, with depth changes, effect of high oxygen tensions and 'silent' bubbles on the foetus, hypoxia subsequent to salt water aspiration, etc. These may eventually be shown to be of serious import.

DIVING HISTORY

A knowledge of previous hyperbaric, hypobaric and aquatic accidents may be invaluable in an assessment of future problems.

DIVER SELECTION

The above discussion has dealt with what medical standards are required for diving. A much more complex situation exists when attempts are made to define what standards are optimal or ideal. These standards will vary for each type of diving activity, but in the one large navy series available on diver selection, the diver was found to be a psychologically stable, medically and physically fit individual, who is not overtly worried by diving hazards and has both a capability and a desire to function in a hyperbaric aquatic environment. In comparison with the unsuccessful candidate, he is usually more mature, motivated by an affinity for water sports, very capable at swimming and breathholding. He is not motivated by adventure or comradeship. He is a thickset individual with a low Cotton's Index of build, a non smoker, and based on psychometric assessment, he is an intelligent, non-neurotic, self sufficient and practical person.

SKELETAL SURVEY

General

The basic skeletal survey now recommended by MRC Decompression Sickness Registry has evolved over the years and particular acknowledgment is given to the valuable contribution made by those who attended the International Working Party on dysbaric osteonecrosis at the Naval Submarine Medical Research Laboratory, at New London, Connecticut in September, 1974.

The basic survey should include the following:-

a) AP radiograph of each shoulder joint.
b) AP radiograph of each shoulder joint with arm in internal rotation.
c) AP radiograph of each hip joint.
d) AP radiograph of each knee joint.
e) Lateral radiograph of each knee joint.

The early demonstration of dysbaric osteonecrosis demands high quality radiographs which clearly demonstrate the bone traceculae. This will require the optimum screen/film combination, an adequate ratio grid and a focal spot size of 1 mm to 2 mm. A smaller size with a high speed rotating tube should be used if this is available. Gonad protection should always be used. A list of recommended projections and specimen radiographs illustrating these views should be available for the radiographer. Where possible, the radiographs should be checked before the patient leaves the X-ray room or department and preferably this should be done by the radiologist responsible for the interpretation. It is of considerable advantage to have the surveys done in as few centres as possible so that the radiography technicians become closely involved in the work and are fully aware of the problems in interpretation and the need for high quality radiographs.

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EUROPEAN UNDERSEA MEDICAL SOCIETY

The 1982 Annual Meeting of EUBS is due to be held in Lübeck, West Germany on 6th and 7th October. Additional days are to be arranged for visits to GKSS (1000 m wet chamber) and to the Institute of Naval Medicine at Kiel (celebrating its 50th Anniversary).

The local organiser is Captain Klaus Seeman (Past President -EUBS) but if any SPUMS members would like details, please write now to Dr David Elliott (President EUBS) Rockdale, 40 Petworth Road, Haslemere, Surrey, GU27 2 HX, England.

HEALTH AND SAFETY EXECUTIVE RECOMMENDATIONS MEDICAL EXAMINATION OF COMMERCIAL DIVERS IN THE UNITED KINGDOM

INFORMATION FOR EXAMINING DOCTORS

NOTE Only those doctors on the APPROVED LIST are authorised to provide valid fitness-to dive *certification for* commercial *divers.*

INTRODUCTION

The recommendations deal with specific aspects of diving medical examinations, but the examining doctor's clinical opinion on fitness or unfitness should be formed on the whole of the medical examination. The section of the paper on "The Medical Examination" opens with general advice to doctors conducting diving medicals to be specially sensitive to the potentially serious effects of minor illnesses in divers and to the need to assess the possible repercussions of episodes of past ill health.

It is difficult to lay down absolute standards for some aspects of diving medical examinations and best current practice has been followed throughout the recommendations. On-going research may affect some aspects and the recommendations will be up-dated when necessary.

Any medical unfitness which debars a diver from his occupation temporarily or permanently is a most serious matter where employment is highly lucrative but often of limited duration, and where it would be very difficult, if not impossible, to find suitable alternative work. Where an examining doctor is in doubt about the medical fitness of the candidate, he should obtain a further opinion from another doctor approved to carry out medical examinations under the Regulations or from a specialist on any specific medical aspect of the case, in the first instance. Where a candidate is declared unfit he should be informed that he may appeal to the Director of Medical Services, Health and Safety Executive, for a final ruling.

THE MEDICAL EXAMINATION OF DIVERS

In general, a high standard of physical and mental fitness is required for diving. Consequently, in addition to excluding major disqualifying medical conditions, examining medical officers should identify and give careful consideration to minor chronic, recurring or temporary mental or physical illnesses which may distract the diver and cause him to ignore factors concerned with his own or others' safety.

The diver's past or projected employment will determine the scope of certain items in the medical examination.

Particular attention must be paid to past medical and diving history. Any doubt in either of these areas should be clarified by obtaining further details to enable a correct evaluation of their significance. The diver should be asked specifically for details of any current medication.

Exposure to pressure shall not normally form part of the medical examination.

MEDICAL STANDARDS

The following bodily systems should be evaluated from the history and examination. Where relevant, numerical values are given.

The standards shall apply to all divers but certain groups of divers may require less frequent long bone X-rays.

AGE

The minimum age for a diver subject to the provisions of the Health and Safety at Work Diving Regulations is 18 years. There is no upper age limit for diving providing all the medical standards can be met. Serious consideration must be given however to the need for divers over the age of 40 to have adequate reserves of pulmonary and cardiovascular fitness for use in emergency, and therefore to the possibility of a professional diver's career having to be terminated on these grounds.

OBESITY

Obesity is a particular hazard to divers and may also imply a lack of physical fitness. Any diver over 20% in excess of his recommended weight based on currently accepted height/age tables should be disqualified from diving until he has lost sufficient weight. In general a figure of less than 15% in excess of the recommended weight should be aimed at. It should be noted that many height/age tables do not allow for variations in body type and examining doctors will wish to take this into account.

SKIN

There should be no evidence of chronic or acute skin disorders such as are likely to be affected adversely by friction from dry diving suits, prolonged immersion or prolonged exposure to the high humidity, elevated temperature environments which are commonly encountered in saturation diving.

EARS, NOSE AND THROAT

1. Both tympanic membranes must be intact and mobile when a Valsalva test is carried out. This test should confirm the patency of the Eustachian tubes.
2. Any evidence of chronic outer or middle ear discharge must be cause for rejection.
3. Any evidence of chronic or recurrent sinusitis, catarrh or severe allergic conditions of the respiratory tract should be cause for rejection.
4. Any history of middle ear surgery (including tympanoplasty) should be referred for specialist opinion before any decision is made.

Audiometry

Annual Audiometric examination should be carried out where indicated by past history of noise exposure, barotrauma, decompression sickness affecting the ear or deafness. A hearing loss in either ear of 35 dB or more at frequencies up to 3000 Hz and 50 dB or more at frequencies above 3000 Hz is an indication for referral of the candidate to a specialist for further opinion, unless the examining doctor is convinced that such hearing loss is unlikely to be significantly increased by continuous diving activities.

RESPIRATORY SYSTEM

1. Particular attention must be paid to any condition that might cause retention or trapping of expanding gas in any part of the lungs during decompression.

2. The following conditions will automatically disqualify:
   a) Any chronic lung disease, past or present.
   b) Any past or present evidence of obstructive airways disease (eg. asthma, chronic bronchitis, allergic bronchospasm).
   c) Any history of spontaneous pneumothorax, perforating chest injuries or open chest surgery.
   d) Any fibrotic lesion of the lung that may cause generalised or localised lack of compliancy in lung tissue.
3. A large plate postero-anterior chest X-ray shall be normal.

Pulmonary Function Tests

1. All divers should have annual pulmonary function tests to establish Forced Expiratory Volume at 1 second (FEV_1) and Forced Vital Capacity (FVC).
2. An FVC of less than 3.5 litres and an FEV/FVC ratio of less than 75% at the pre employment medical examination and 70% at subsequent examinations are causes for rejection unless further pulmonary function testing reveals no abnormality.

DENTAL

1. Candidates should have a high degree of dental fitness and any abnormalities of dentition or malformation of the mandible likely to impair the candidate's ability to securely and easily retain an unmodified diving equipment mouthpiece should debar.
2. Removable dentures should not be worn when diving.

CARDIOVASCULAR SYSTEM

1. There should be no evidence of heart disease and any arrhythmias must be fully investigated.
2. Ideally the resting blood pressure should not exceed 140/90 mm Hg.
3. An exercise tolerance test should be carried out. It is suggested that the Army Physical Fitness Test be adopted but other equivalent tests are acceptable. The candidate should be required to step, at a rate of 30 times per minute onto a height 17 inches (43.14 centimetres) for five minutes. A standard of Sum of Pulse Counts should be applied. 30 second pulse counts (P_1, P_2, P_3 are taken at 1 minute, 2 minutes and 3 minutes post exercise. P_1, P_2, P_3 are then added together and a test score of 190 or less should be taken as the indication of fitness.
4. Severe varicose veins must be a cause for rejection. Varicose veins are not a cause for rejection if treated.

ECG Examinations

a) All divers should have a resting standard 12 Lead ECG at initial examination and annually after the age of 35 years.
b) Post-exercise or stress ECG's should be at the discretion of the examining doctor.

ALIMENTARY SYSTEM

1. Peptic ulceration should be a cause for rejection unless there is endoscopic evidence of healing and the candidate has been asymptomatic for at least one year.
2. Any abdominal hernia should be a cause for rejection until satisfactory treatment has taken place.
3. Any other chronic gastro-intestinal disease (eg. ulcerative colitis, cholelithiasis) should be cause for rejection.

MUSCULO-SKELETAL

Any impairment of musculo-skeletal function should be carefully assessed against the general requirements outlined earlier.

LONG BONE AND JOINT X-RAYS

X-rays of long bones and joints, taken in accordance with the recommended MRC Decompression Sickness Panel techniques, should be carried out on all divers at initial examination, with the exception of divers who indicate that they will not be diving, on compressed natural air, to depths greater than 30 metres and whose total exposure time to pressure will not exceed four hours on any single occasion. Such examinations should then be carried out annually, if appropriate, considering the diver's experience over the previous three years, with the following exceptions:-

a) Annual X-rays are not required for divers using only compressed natural air who have not been exposed to pressure more than the equivalent of 30 m sea-water and whose total exposure time on any single occasion has never exceeded four hours.
b) X-rays at intervals of three years will suffice for divers using only compressed natural air who have not been exposed to pressures greater than the equivalent of 50 m sea-water and whose total exposure time on any single occasion has never exceeded four hours.

Therapeutic compression for a decompression illness will exclude divers from the exemptions set out in categories a) and b) above, for three years. Except where indicated clinically long bone X-rays should NOT be repeated at intervals less than those specified above.

CENTRAL NERVOUS SYSTEM

1. A full examination of the central nervous system must show normal function, but localised minor abnormalities such as patches of anaesthesia are allowable provided generalised nervous system disease can be excluded.
2. Any history of fits (apart from childhood febrile convulsions), intra-cranial surgery, blackouts, severe head injury involving more than momentary unconsciousness or concussion, and migraine, should be a cause for rejection. If the severity of head injuries is in doubt, any further opinion should include an EEG examination. A history of repeated headaches should also be a cause for further investigation.
3. Any past or present evidence of psychiatric illness should be cause for rejection unless the examining doctor can be confident that it is of a minor nature and unlikely to re-occur. Particular attention should be paid to any past or present evidence of alcohol or drug abuse.

VISION

1. The following visual acuity standard should be the minimum acceptable:-
   a. Uncorrected distant:-
      R. 6/36. L. 6/36
      Both eyes 6/24
   b. Uncorrected near:-
      R. J 16 (N24). L. J 16 (N 24)
      Both eyes J 15 (N18)
2. Visual fields should be normal on simple testing.
3. Fundi should be normal.
4. Colour vision should be tested at initial examination and candidates be informed of any abnormalities which should also be detailed in their log-book and certificates of fitness.

GENERAL

1. Chemical and microscopical examination of the urine should be performed at the initial examination and repeated by accepted dipstick techniques subsequently. Glycosuria calls for investigation before acceptance. Albuminuria may be innocent, but acceptance should only be considered after 24 hour protein excretion studies.
2. A full blood count and test for Haemoglobin "S" must be carried out at the initial examination. The sickle cell trait is more common in certain ethnic groups and evidence of its presence should be cause for rejection. At the initial examination and every subsequent examination Hb of less than 12.OG and a PVC of less than 40% should be cause for rejection pending further investigation.
3. Any speech defect which may prevent clear, instant communication with or without stress should be a cause for rejection where this is relevant.

FREQUENCY OF EXAMINATIONS

1. All divers should have examinations at intervals not exceeding one year.
2. Any illness or injury resulting in inability to dive for a period exceeding seven days shall require renewal of the certificate of fitness to dive after such re-examination as is considered necessary by the examining doctor. In addition, any diver sustaining a decompression illness resulting in neurological or vestibular manifestations, even though therapy appears to have been successful, must be medically examined before resuming diving.

DIVING RESTRICTIONS

1. The examining doctor may for reasons of age or other factors revealed by the medical examinations elect to impose limitations as to the duration and depth to which a diver may dive or the length of validity of the certification of fitness to dive.
2. Any such limitations must be clearly identified on the certification of fitness to dive.

LOG-BOOKS

1. In addition to the details which are recorded on the medical examination form, the results of the examination will be recorded in the diver's log-book together with dates of chest, bone and joint X-rays.
2. The examining doctor will make an entry in the log-book as to the fitness of the candidate to dive and any restriction that he may wish to impose.

THE WORLD UNDERWATER FEDERATION SPORTS DIVER MEDICAL

CMAS (the World Underwater Federation) provides a medical examination form for sports divers. In the 1981 edition the history includes questions on Sports currently practiced and Sports accidents (including diving accidents) as well as a comprehensive medical history.

Have you ever suffered or do you suffer from any of the following? Answer yes or no. If yes, give details and date.

Nose and sinus *- Operations? Sinusitis? Hay fever?*

Ears *- Otitis? Ear discharge? Hearing or balance trouble? Buzzing in the ears?*

Head and brain *- Cerebral lesions? Commotion of the brain? (fits) Frequent headaches? Epilepsy? Loss of consciousness? Vertigo, fainting? Nervous attacks? Anxiety -*

Claustrophobia, Agoraphobia? Seasickness ?

***Respiratory system** - Tuberculosis? Asthma? Pleurisy? Pneumothorax? Frequent bronchitis? Breathlessness after slight effort?*

***Cardiovascular system** -Cardiac trouble? Pain or fear states? Hypertension or Hypotension? Varices? Phlebitis? Embolism?*

***Digestive system -** Stomach ulcer? Colic? Jaundice? Hernia?*

***Urogenital system** - Nephritis? Pyelonephritis? Renal calculus? Syphilis?*

***Skin, Bones, Joints** - Allergies? Rheumatism? Habitual Luxation? (recurrent dislocation).*

***Eyes** - Glaucoma? Impairment of vision?*

Operations, Accidents, Poisoning, hospitalisation, Other illnesses:

Feverish conditions or illnesses during the last 3 months.

***Women** - Pregnancy?*

***Tobacco** - quantity*

***Alcohol** - quantity*

Drugs taken

Have you every been declared unfit for sports?

Last chest X-ray

Other examinations

The candidate signs the form to certify the correctness of his or her answers.

The medical examination includes the following as essential tests. They must under no circumstances be omitted. *In individual cases, at the first examination and if over 40 years of age they will be more thorough* whatever that means.

Height

Weight

General Condition - Amputations, Malformations Scoliosis, Adiposity.

Head:

Eyes - Reflexes of pupils.

Vision - Dioptres - if spectacles worn - and astigmatism.

Nose and Sinuses - Allergic rhinitis or sinusitis.

Ears and Eustachian Tubes - Ear wax, State of eardrum, Acoustic or visual test of tube permeability.

Hearing - Right and Left - Whispering heard more than 1 metre away, watch movement, if abnormal: audio tympanometry.

Oral cavity - Denture wearers must be able to hold the mouthpiece.

Pharynx - Rhinopharyngitis? Tonsillitis?

Thorax - Chest expansion must not be less than 5 cm

Lungs - Spirometry (FEV% recommended).

Heart - Blood pressure (Must not exceed 160/ 100 Torr)

Neurological Findings - Psyche - Psychic instability, pronounced neurovegetative dystonia make a person unfit for diving (see Flack Test).

Flack Test - Adaptation test of neurovegetative system. After breathing in as deeply as possible maintain a pressure of 40 mm Hg when blowing into a sphygmomanometer for a period of: men 40 sec, women 30 sec, children under 14 20 mm Hg 20 sec. The pulse count taken over a period of 5 sec during the exercise must not exceed 10/5 sec.

Exercise Test - Ruffier Test -

1. *1 minute rest.*
2. *Pulse/min (P) after this rest.*
3. *30 kneebends in 45 sec.*
4. *Pulse/min (P1) immediately after.*
5. *Pulse/min (P2) after one minute.*

(Pulse measured over a period of 15 sec each time).

Index: $\underline{P:} \quad \frac{\underline{+P1} \quad \underline{+P2} \quad \underline{-200}}{10} =$

Normal: Index 0-3 very good; 3-5 good; 5-10 average; 10 inadequate

Optional tests include *cold water caloric testing.*

***X-ray** - Actinoscopy and radiography of the thorax are urgently recommended.*

***EGG** - Advisable at the first examination and over 40.*

***EEG -** In all cases suspected of "attacks" eg. convulsions.*

***Audio-tympanometry** - (a) if unable to hear whispering at less than 1 m; (b) at first examination; (c) every three years if over 40.*

***Electronystagmography** - if cold water test abnormal.*

Obviously the interpretation of the significance of the history and examination is left to the examining doctor. The CMAS fitness test guidelines are not very influential outside France. Dr OF Ehm, who was Chairman of the Committee, presented his views on the 1981 guidelines at the meeting of the Medical and Prevention Commission of CMAS at Cancut, Mexico in December, 1980. We are grateful to

INTRODUCING THE NEW DIVING-FITNESS TEST GUIDELINES (1981 MODEL)

OF Ehm

It was only some 30 years ago that diving medicine first turned its attention to the question of sport-diving fitness. The guidelines existing at that time for naval and professional divers were only partly relevant for sport-diving. This meant that the various countries came up with their own individual solutions to the question of fitness-test guidelines.

The increasing popularity of amateur diving brought with it the need for standardised procedures, a task that fell to the CMAS at an international level. In accordance with the priorities of the time this was undertaken first of all for underwater spear-fishing, then for the individual sport disciplines and diving training.

At the urgent request of the smaller federations, a standardisation for fitness tests was also undertaken. The first CMAS fitness test guidelines were completed in 1970 under the aegis of Dr Lescure. They never became really influential outside France.

At the 3rd International Sport Diving Symposium in Martinique in 1975, a "Fitness" work-group was set up with a view to co-ordinating opinion on fitness tests for a new version of the guidelines.

As Chairman of the work-group, I had circulars sent to all the national medical commissions of the CMAS, requesting suggestions and comment. Apart from a few suggestions from France, nothing was forthcoming. In 1977 however, the Swedish federation as represented at the Brisbane general assembly of CMAS (not the assembly of CMP!) moved for amendments in the 1976 fitness guidelines. They suggested replacing it with the guidelines of the Scandinavian federations, urging in particular that the Flack test be dropped and the Harvard Step Test substituted for the Ruffier Test.

With a view to gathering further opinion on this Scandinavian proposal, a further circular was sent out to all the national commissions in 1978. In addition to the request for amendment suggestions it contained inquiries into the extent of diving accidents as a result of unknown causes or errors not detected in the course of fitness tests. Neither the circular itself nor personal conversations have provided a clear answer to this question. Two communications, again from France, were all that materialised in connection with the other questions.

In January 1979, in the course of a meeting of the "Fitness" work-group of the CMP in Monaco, the Swedish proposals were discussed and voted on. The decision was to retain Flack and Ruffier in the new guidelines and to preface these with a questionnaire on the patient's medical history.

The result is the draft that you have before you. It takes account of all the fitness guidelines of federations represented in the CMAS that were available for perusal. As such it embodies 20 years of experience in the previously uncharted territory of sport-diving medicine.

Basic to this draft as it stands is the idea that our role as physicians is a purely consultative one. We advise the diver - as we do the patient - whether he should dive or not. Tests for the navies or professional diving (frogmen) make entirely different demands on the responsibility of the examining doctor. In civilian and sport diving, the "patient" must be allotted his share of the responsibility. The questionnaire in its new form is an attempt to serve this purpose, while at the same time making the examining physician's task easier.

A fitness test cannot of itself be a full scale clinical examination and this is not its purpose. Also, the CMAS guidelines must not be limited to the problems and possibilities of the industrial countries alone, they must be applicable for all the federations throughout the CMAS. Nor can these guidelines take account of statutory particularities in individual countries. They are meant as a guide, as a model.

The instructions for the examining doctor cannot be a complete vade-mecum. The experienced doctor doesn't need them, the inexperienced doctor probably won't read them anyway.

The Ruffier test is certainly adequate for the performance test. Of course there is nothing stopping the individual physician from running a test at the bicycle-ergometer or any other stress tests.

The Flack test is the simplest and most reliable test for detecting abnormalities in the neuro-vegetative system. The majority of diving doctors in Monaco came out in favour of its being retained.

The value of a fitness test depends on the quality of the doctor involved. It is a further task of the CMP to try to influence that quality for the better!

THE BS-AC SPORTS DIVER MEDICAL

The BS-AC medical history requirements are different. The candidate has to answer the following questions.

Ear trouble, earache, discharge deafness.

Sinus trouble.

Chest disease, including Asthma, Bronchitis or TB, Pneumothorax or collapsed lung.

Attacks of giddiness, blackouts or fainting.

Fits or any nervous disorders, including persistent headaches or concussion.

Anxiety, "nerves", nervous breakdown.

Diseases of the heart and circulation, including high blood pressure.

Have you attended or been admitted to hospital.

Are you diabetic.

Do you wear dentures.

Do you regularly or frequently take any medication or other treatment with or without prescription.

Have you ever had any serious illness, accident or diving incident.

Are you currently receiving medical care or have you consulted any doctor in the past year.

Have you every been refused a diving medical certificate, life insurance or offered special terms.

Has there been any change in your physical or mental health since your last medical.

Do you smoke. (Give an approximate indication of number of cigarettes per day or amount of pipe tobacco per week in further details section.

The medical examination form states:

You are asked to pay particular attention to the ENT and respiratory systems and to bear in mind that underwater swimming involves severe exertion

Spaces are provided for notes about both ears; height and weight; sinuses, nose and throat; urine testing; chest; CVS: abdomen; joints and limbs; chest X-ray; B/P; CNS; personality and mental disorder.

On the back of the form are the medical standards set out by systems and divided into disqualifying factors, allowable factors and other points.

The disqualifying factors are:

Gross obesity. Impaired exercise tolerance.

Perforated eardrum in new recruits. Chronic vestibular disease in new entrants.

Suspicion of active tuberculosis. Lung cysts or bullae, even after surgical treatment. Any surgical removal of lung tissue. Tuberculosis scars other than healed primary focus in new recruits. History of spontaneous pneumothorax.

Clinical, or where appropriate, ECG evidence of ischaemic heart disease. Aortic valve disease. Evidence of heart disease other than lone systolic murmur, should be referred. Symptomatic or pathological arrhythmias. Diastolic pressure over 100 mmHg in established divers and 90 mmHg in new entrants, or other evidence of hypertensive disease. Antihypertensive therapy. Sickle cell trait. Haemophilia and polycythaemia will disqualify.

Proteinuria, until the cause has been established.

Disease, amputation or deformity excessively limiting ability to swim. (May be issued with a restricted certificate at discretion of Referee).

Diabetes in new entrants, or diabetes newly arising in established divers.

History of confirmed epilepsy, including post-traumatic fits, to disqualify, no matter how long since last episode. Any serious head injury in past 3 months. Overt psychiatric or personality disorders. Petit Mal also to disqualify.

The use of the following disqualifies: Sympathomimetics, steroids, Beta-blockers, muscle relaxants, antihypertensives, all diabetic drugs, digoxin, diuretics, Psychotropic drugs - see comments in Other Points column. Alcohol abuse to disqualify.

Allowable factors and other points are:

Basic swimming test ('AS test') is normal standard of exercise tolerance. If a repeat medical examination is necessary, the "A" test should be requested.

ENT

Perforated ear drum known to have been present during several years of diving.

Valsalva test of drum mobility optional but outweighed by practical diving test.

Deafness - at discretion of Medical Referee the candidate may be restricted to diving with a fit companion. Sinusitis may benefit from diving!

ORAL CAVITY

Dentures must be retained in place on fully opening the mouth and not be dislodged by placing jaws together in any position, or by movement of one denture against the other. They should extend to the muco-buccal fold. If dentures do not satisfy these requirements, they should not be worn while diving. Cleft palate not acceptable without Referee's opinion.

Applicants should be advised about bad teeth and fillings but these should not normally disqualify.

R.S.

Mild chronic bronchitis without emphysema or important airways obstruction, if exercise tolerance and chest X-ray normal. TB scars in established diver, subject to Referee's opinion.

Miniature chest X-rays shall normally be acceptable. A full-size film may be required in doubtful cases. Chest X-ray is normally required every 5 years up to age 30 and every 5 years thereafter. Asthma should always be referred to the Medical Referee. Examining doctor must see chest films or report. If not available, endorse certificate to the effect that member must show valid chest X-ray report to Diving Officer. X-ray at the time of examination must be within 6/12 except when over 50 years of age.

CVS

Minor asymptomatic heart disease other than ischaemic (subject to more frequent medical checks). Mild anaemia, but advise treatment.

Post-exercise ECG recommended every 5 years after age 50. If there is any difficulty in arranging this, the local Medical Referee may be able to help. ECG not otherwise routinely required. Sickle cell test only where clinically indicated.

ABDOMEN/U.G.S.

Peptic ulcer, unless unduly active or troublesome. Abdominal hernias (but advise repair). Pregnancy (note restriction on depth and duration).

LIMBS

Arthritis, amputation or arthrodesis not severely limiting ability to swim or rescue others.

If ability to rescue others is impaired, must not dive with less than two healthy experienced companions.

ENDOCRINE

Those diabetic divers already practising at April 1975 may continue, provided that they satisfy a list of special requirements. Referral to a Medical Referee is suggested for all endocrine disorders.

NERVOUS SYSTEM

A single isolated fit or severe head injury to be referred to Medical Referee. previous CNS "Bend" also to be referred.

DRUGS

Antihistamines and analgesics should only be used with caution. Oral contraceptives are allowable. Smoking is allowable but reduces fitness and predisposes to air embolism, pneumothorax and coronary thrombosis.

If any psychotropic drug (including tranquillisers, sedatives and hymnstics) have been used, the candidate should not dive for at least 3 months after complete cessation of therapy, without the consent of the Referee.

The BS-AC has a system of medical referees to whom difficult decisions are referred. The BS-AC requires a medical examination on entry, thereafter every 5 years to age 30, then every 3 years to the age of 50 and annually thereafter.

OXYGEN CONVULSION DURING IN-WATER PROPHYLACTIC TREATMENT AT 8m

(From STICKYBEAK Non-Fatal Incidents File)

The purpose of the dive was to lay grid lines, a task complicated by the fine, easily disturbed silt on the sea bed. Because of this factor the diver opted to dive alone, to lessen the degree of disturbance and resultant loss of visibility. He was a trained and experienced diver, though assessed by others as being of rapid rather than relaxed movement habits when diving. He had been somewhat unsettled on his (solo) morning dive through becoming disorientated during a zero visibility situation, but was once again diving alone. The sea conditions were calm, depth was 60 feet and the water was said to be relatively cold.

The task was exhausting, visibility poor, and the planned dive time nearly complete when he became aware that one of the lines had become entangled in his back-pack. He immediately made a hurried ascent, not attempting to cut the line, but found himself tethered to the sea floor at 15 few. He therefore ditched his backpack and made a free ascent to the surface, inhaling a little sea water in the process. His surfacing and apparent distress were observed and he was quickly rescued by the surface cover in a zodiac and taken back to the dive boat. There it was considered that the rapid, no-stops ascent might result in decompression sickness and he was put back in the water wearing a full face mask for a 100% oxygen prophylactic treatment at 8 m. He was accompanied by another diver. He was noted to suddenly loose consciousness and suffer fits, so was hurriedly brought back to the surface and got onto the dive boat. There he rapidly recovered, the only symptoms being those of a mild sea water inhalation syndrome.

Subsequent investigations, including EEG, revealed no abnormalities. It is suggested that critical factors in the potentiation of the oxygen convulsion were exhaustion, cold, apprehension due to nil visibility and the entanglement while alone, and the salt water inhalation. Critical factors in his surviving this convulsion were the use of full face mask and the presence of an alert buddy, both prerequisites before using such a therapeutic diving procedure.

PULMONARY BAROTRAUMA: TWO NON-FATAL CASES

(From STICKYBEAK Non-Fatal Incidents File)

There is a common belief among divers that Pulmonary Barotrauma is solely, and inevitably, the result of careless rapid ascent without exhaling. The result is expected to be immediate and final disaster. The low numbers of fatalities known to have followed "Free Ascent" practice ascents is held by some to indicate that there has been a medical over-reaction to a rare misadventure and to indicate the basic safety of such practice ascents. As the following case shows, disaster can strike without warning and it is a matter of chance whether the instructor has to explain his actions in a hospital casualty ward or to a Coroner and distressed relatives. As the dangers of "Free Ascent" practice are a matter of record and the supposed benefits to the diver an unproved quantity, it is wise. To avoid such trial emergency ascents in favour of inculcating the established and tested rules of diving-safely modes. The second case illustrates the narrow margin which exists between an uneventful dive and one resulting in pulmonary barotrauma. Few people would expect clinically apparent lung damage to occur due to a 5-10 feet ascent while at 30 feet, which gives added force to follow the rules for safe diving with great care at all times.

Case 1

This trainee diver had received a "Diving Medical", which did not include a Chest X-ray, before commencing the course. The victim-to-be had made several shallower "Free Ascents" without trouble on the previous weekend and on this occasion was one of three pupils taken by boat to make additional ascents, this time from 20 m. The weather was fine, the sea calm and visibility about 3 m at 18 m depth. The instructor descended with the pupil down the shot line and waited while mask squeeze was corrected at i0 m and 20 m, sea floor. He watched and was certain that the correct "Free Ascent" drill was followed and that ascent was at the rate of the smallest bubbles. Exhalation seemed to be correct, and large volumes of air were seen to be exhaled with increased rate of ascent from 3 m to the surface. However at the surface the victim was seen to be unconscious and starting to shake, ie. was having a fit.

The victim was rapidly taken into the dive boat, a radio call was made for a fast boat to take him back to shore, and the airway was maintained. A fast launch conveyed the victim to shore and an ambulance continued the journey to the nearest hospital. On admission to the Casualty Department hyperventilation (with carpo-pedal spasm), irritable crying and a barely rousable condition were noted. About 4 and 3/4 hours later fits recurred and treatment with both IV Diazepam and Phenytoin was commenced. Chest X-ray showed pneumo-pericardium but no pneumothorax. It was a further 80 minutes before a doctor with knowledge of diving medicine became aware of these events and contacted the nearest RAN facility with a RCC. The victim was transferred there for treatment, now in Status Epilepticus with a predominantly right sided fit, head and eyes turned to the right. There was a mild pyrexia, BP 140/80, pulse 140/min and no response to commands or to deep pain stimuli. Petechiae were present in the mask area. Retinae and Tympanic membranes were normal. Pupils were widely dilated, equal and unresponsive to light. Dextran 70, Dexamathazone and further Diazepam were given before the victim was transported from the hospital. The Dextran was continued but no further drugs were given before therapeutic recompression therapy. The bladder was catheterised and the chest was examined. There were no adventitious sounds.

Recompression was to 30 msw, maximum "depth" possible with this chamber. There was no apparent response at depth or during the oxygen phase of the treatment (from 18 msw), though the fits lessened. Following this treatment the victim was returned to the original hospital and placed in the Intensive Care Unit. Thiopentone IV was given overnight. The patient woke gradually some 12 hours later to a full memory retention for the incident and the subsequent admission to hospital. There was extreme tiredness and some weakness, particularly on the right side. This gradually resolved and no further recompression therapy was considered necessary. Follow-up has shown that recovery, which was aided by physiotherapy, was apparently complete.

Case 2

The purpose of this boat dive was to locate and recover a missing RAAF radio and parachute. The victim was newly trained, the buddy's training and experience was not recorded. Neither wore a depth guage or watch or had a contents guage. It was a hard dive and the victim was troubled by getting water with each inhalation, while his buddy was troubled by the float line's shortness. They were connected by a 1 m buddy line.

At one stage, while at about 30 feet depth, the victim took his demand valve out of his mouth "and fiddled with it", holding his breath till he replaced it and took another breath. At the same time his buddy decided to ascend to the surface because of his annoyance with the float line. This ascent was sufficiently gentle in nature for the victim to be unaware of its significance: he claimed later to be unaware of the need to exhale in such circumstances. Ascent with breath held was estimated as 5 to 10 feet.

About 45 minutes after surfacing the victim noticed that his throat and neck felt sore and there was some chest tightness on inspiration. Neck fullness was noticed 3 hours later. He returned home but went to a hospital when respiratory difficulty and surgical emphysema became apparent. He had chest pain and marked discomfort from dyspnoea. Treatment was oxygen by mask for two days, started 24 hours after the dive. About four days after the dive he felt fully recovered but surgical emphysema was apparent for about five days. There was no pneumothorax and later chest X-ray was normal.

DISCUSSION

These cases illustrate, inter alia, the scope for improvement in the management of diving incidents. In Case 1 the good result

was more a consequence of the small sizes of the air emboli, which produced marked local reactions but little CNS destruction, than of the non-specific initial treatment. The delay in contacting any recompression unit might have had a less happy result if it had occurred in another case. In Case 2 the delay in seeking treatment could have been serious had the surgical emphysema increased more rapidly and severely at home. It is hoped that trained divers will be alert to the possibility that the diving troubles they learn about may actually occur in themselves or their buddies. They should INSIST on others taking notice of any possible diving relationship to their, or their buddy's, troubles and NEVER EXPECT A NON-DIVER TO UNDERSTAND DIVING-RELATED DISABILITIES!

SPUMS 1981 SCIENTIFIC MEETING

THE DECOMPRESSION DISEASES
PART ONE

David Elliot

I think it is important to include both types of decompression illness together, because there are many occasions when the differential diagnosis between the two is not only difficult but really, from a practical point of view, rather unimportant. So, instead of breaking it up into pulmonary barotrauma and decompression sickness, I am going to lump them together, call them decompression illnesses and then deal today with pathogenesis and presentation, leaving treatment for tomorrow.

I am aware that the group here has probably had quite a lot of this in past years. I am also aware that some of you are not so familiar with diving accidents. So as a matter of policy I will go for some fairly elementary stuff, even though this will be repetition for some of you. Repetition does not do any great harm and helps to reinforce existing knowledge. Also, coming from North-west Europe, I may well have a different slant on decompression illnesses to some of the previous speakers who have been to SPUMS meetings. In a number of treatment seminars over the past few years, there have been many arguments not only between the Anglo and the American groups, but particularly between the Anglo-American and the French groups of diving doctors. I think that it is very important to air differences, because they emphasise the fact that we certainly do not know everything about the subject. Indeed if you meet anyone who says that he knows all about the subject, the only thing that you know about him is that he does not know anything about

The dysbaric illnesses comprise two illnesses, pulmonary barotrauma and decompression sickness. Pulmonary barotrauma is the illness due to the expansion of gas inside the chest, whereas by definition decompression sickness is the illness which arises from bubbles from gases that have been dissolved in the tissues. The first essential point of today is that as diving emergencies both comprise one syndrome, the decompression disorder and to subdivide these into minor and major, or serious, varieties of the disorder is useful in retrospect, but in practicality I would suggest we avoid it, because every single such instance must be regarded as an emergency, until you have got it sorted out.

PULMONARY BAROTRAUMA

Two reminders about Boyles Law, which I trust everybody knows inside out. The compression of the air in an inverted bell jar in water is exponential. The rate of expansion is greatest in the last few feet.

When a men does a buoyant ascent from a submarine he comes up very fast. The stole of his survival suit is inflated and venting. The enormous trail of bubbles gives some idea of the rate of gas expansion that can occur during a rapid ascent. He comes up between five and eight feet per second. The slide is of a submarine escape instructor coming up from a submarine at 600 feet. That incidentally is a compressed air dive, a twenty second compression to 600 feet, 4 seconds bottom time and then a minute and a half back to the surface. The slide gives a really remarkable illustration of the amount of gas which is vented. The picture was taken about 40 or 50 feet below the surface.

Causes of Pulmonary Barotrauma

What are the causes of pulmonary barotrauma? Bear in mind that an overpressure of a mere 80 mm of mercury is quite sufficient to blow a set of lungs. The first and most common cause, failure to exhale during rapid ascent, is something which we should be able to avoid by good training of both divers and submarine escape trainees.

The second most common cause is some form of local pulmonary pathology, that causes a retention of gas in the lung. The various causes include tuberculous glands, cysts, some sort of lung pathology which on the whole can be detected by X-ray. One of the things which therefore will come out when we are discussing fitness for people for sports diving, is whether or not an annual chest X-ray should be mandatory. It certainly is for professional divers. But the point about the chest X-ray is that of course it is a very gross test and there are many reports of people who have had serious pulmonary barotrauma who have breathed out properly during their ascent, and who have had perfectly normal chest X-rays within a very short period before that ascent. There was the Australian report of increased compliance of the lungs of such people, which may have been post-hoc rather than propter-hoc.

The third case in the normal individual making a normal ascent, is airway collapse. You can demonstrate that with fast rates of flow the airways will naturally collapse at the equal pressure point, and therefore dam up the peripheral gas. This is something which one can not train the diver to avoid. One can not detect it with X-rays. But for it to happen one has to come up extremely fast. However,

even in an emergency, making a buoyant ascent, you still have quite a lot of control over your rate of ascent. All you have to do is to come up with your legs astride and your arms out instead of keeping yourself streamlined. It is remarkable how much drag that will cause to slow you down. If you think you are coming up too fast, or are out of control, or even if you are breathing out properly, stick your arms and legs out and it will really slow you down.

Pathophysiology

The pathophysiology of decompression barotrauma we can deal with fairly quickly. Pneumothorax obviously, possibly tension pneumothorax, which is very occasionally bilateral. On the whole, pneumothorax on its own is unusual. Much more commonly the gas goes along the peri-vascular sheaths, causing mediastinal emphysema, pneumopericardium and retro-peritoneal gas. I have one slide which is a very nice view of the upper pole of the right kidney neatly outlined with alveolar air. The gas can spread. The diagnostic point is gas subcutaneously in the anterior triangle of the neck. If it is not there, he may still have burst a lung. But if it is there, then we can say quite positively that there has been a episode of pulmonary barotrauma.

However, the most important thing is the arterial air embolism. I prefer to use arterial gas embolism, because I am not dealing just with compressed air divers. It has been shown quite reasonably well scientifically that the gas tends to enter the pulmonary capillaries as the diver takes his first breath on reaching the surface. The gas is dammed up in the lungs until that particular moment. The clinical picture which follows is just a few seconds of circulation time from the lungs to the brain before the guy goes unconscious. The gas enters the pulmonary capillaries and will distribute by buoyancy, which also has been well demonstrated experimentally, to the carotid arteries and to the vertebrobasilar arteries. I do not think that particular point has been fully appreciated. It has been shown experimentally that vertebrobasilar embolism will cause cardiac irregularity as a reflex. There is of course the possibility of gas embolism to the coronary arteries. It is not surprising that one of the presentations of pulmonary barotrauma is sudden death. It is a cardiac arrest. Work is now going on at the Submarine Escape Training Tank at HMS DOLPHIN to see whether or not one can get a defibrillator that will work at pressure with everybody in that chamber soaking wet.

Now what I have said has been dramatic so far. There are two reports that are both worth attention. In 1964, or thereabouts, the US Navy did some routine chest X-rays of people who made normal buoyant ascents in the Submarine Escape Training Tank. They found that in about 1% of those cases there was evidence of mediastinal emphysema, in perfectly normal people after perfectly normal ascents. The Swedish Navy did some work in their Submarine Escape Tank which showed a 3% incidence of abnormality in otherwise normal ascents. This study is not quite as acceptable because the abnormality is an electro-encephalographic record, but it was well presented. It is clear that it is not an all or none phenomena. It is a condition in which there will be varying grades of cerebral embolism.

In 200,000 man ascents made in the RN Submarine Escape Training Tank over some 20 years, there have been about 88 cases of pulmonary barotrauma, including five fatalities. That is making ascents of from 30, 60 and 100 feet and gives a prevalence of about 1 incident to 2,200 ascents. Those were all buoyant ascents of people who were breathing out correctly and who had normal chest X-rays.

Manifestations of Cerebral Gas Embolism

The manifestations of cerebral gas embolism can happen within a second or so of reaching the surface. The first point is no significant latency. However there can be delayed onset. There was one famous incident at HMS DOLPHIN where a submarine rating finishing his day’s training, actually went on the Gosport Ferry before he found that he was getting giddy, feeling pretty ropey and losing power. Luckily the skipper of the Gosport Ferry was an ex-submariner and knew what was happening. He turned the ferry around and took it straight to HMS DOLPHIN, where the man was immediately recompressed successfully. How can we explain that? I think it is quite simple. If you can imagine that the retained gas in some terminal alveolar unit is rather like a balloon that has been blown up and it may not burst right away. It can stay there under tension. So very rarely you will have a delay in onset.

When DJ Kidd, who is a Surgeon Captain in the Canadian Navy and I were writing a paper together, we found that we were disagreeing quite vehemently, to put it mildly, on the presentation of gas embolism in diving. My basic training at that stage was in submarine escape buoyant ascent and his was in sports scuba diving. It seemed to us that there was a quite distinct difference. In sports scuba diving the onset was not nearly so often as dramatic as it is in the submarine escape training tank. So you may see the dramatic presentation that I described but just because it is not dramatic and immediate does not mean that it is not pulmonary decompression barotrauma and gas embolism.

Of the 88 cases that happened in the 20 years at HMS DOLPHIN, there were 65 with central nervous system manifestations, 30 of them presented as unconsciousness. (Is this relevant to the 5 pm game we are all playing?) 20 of them were disorientated, which included very minor degrees of disorientation, a slight feeling of “not-with-it-ness”. The fact that the guy is just feeling a little bit giddy and may be walking a little bit asymmetrically is quite enough to put one on guard that he is developing some cerebral manifestations of pulmonary barotrauma. Much easier to diagnose are the cases of paresis, of which we had 15. Five were hemiparetic and six were monoparetic in the arm and four monoparetic in the leg, so it can be pretty discreet.

I would like to describe one of those for you as I remember this particular case well. He was just doing an ear run. Now this is a dry pressure chamber run, not even in the water, with a normal diving rate of descent, with an occasional stop as people try to clear their ears, down to 100 feet. As soon as you get down to 100 feet, you stay there for about four minutes and then bring the chamber back to the surface at the normal diving rate of ascent. Theoretically there should be no problems in decompressing at that rate of ascent in a dry pressure chamber. Yet when this particular individual got out of the chamber he found he could not slip one arm into the sleeve of his jacket. I think that is an important case. I would like, although we could never prove it, to make one particular point. I could not prove it in this individual, but we know it is true in others. Some novice divers get all het up about the ears, how you have got to keep ahead of the pressure as you go down. They get a little bit of a thing about always clearing the ears. But the novice diver coming up gets a full sensation in the ears as the ears start to push out the gas from the Eustachian tubes and one or two idiots will go and clear their ears on the way up. One cannot prove that this is a cause of pulmonary barotrauma and gas embolism, but it is a possibility.

Diagnosis of Cerebral Gas Embolism

Bubbles in the retina are said to be diagnostic in gas embolism. This I have never seen. Neither have I seen another so called diagnostic sign. This is called Lieberhastner's sign, which I have never even heard of until I saw it in somebody else's textbook and it is a white mottling of the tongue. I believe that to be a load of rubbish only because I have not seen it. Much more important are the dysphasic and visual manifestations, the slowing of speech, the tunnel vision and I think particularly serious, is the diver who says he is going blind. I know of only one case of such a diver with gas embolism who has actually survived. The three that I myself have seen, who said that they were going blind, all subsequently died. So to me, if someone after an ascent says that they are going blind, it carries a pretty frightening prognosis. However, Jefferson Davis presented a case at the last course I was teaching on, of a man who went blind but recovered. So if you do go blind after your next dive, do not worry, I am sure you will be one of the survivors.

Pathology

Of the five fatalities three were immediately fatal. The various causes I have already hinted at. No one can tell whether respiratory centre embolism, or vertebrobasilar embolism causing reflex arrhythmia or a coronary embolism has occurred. All one can do is to resuscitate to the best of one's ability and see if you can pull him through. Two of the deaths were delayed, one about twelve hours and the other about thirty-six hours. Both had gross cerebral oedema at autopsy, which could have been due either to the bubbles or to the hypoxic episode during treatment. But their cerebral oedema is an indication, I believe, for giving corticosteroids early in serious cases of pulmonary barotrauma. However that is not generally accepted. Because of my personal experience I think it is a good idea to give all CNS cases of gas embolism from pulmonary barotrauma a corticosteroid. However, not everybody would agree.

In one case a post-recompression X-ray showed mediastinal emphysema and some large cysts in the base of the lung. However, these cysts were not the cause of the man's pulmonary barotrauma as he had had a normal X-ray three days before making the ascent. They were the result of the barotrauma.

I would emphasise that in order to get pulmonary barotrauma you only need to have taken one breath of compressed gas, one single breath and the ascent need not have been from a depth greater than 5 or 6 feet. We have on record one CNS case in HMS DOLPHIN which was from a special tank in which there was only 6 feet of water. Now, that is important, because you will find a number of diving superintendents and other experienced divers who, after a person has become paralysed, will say to you, "Look, that can not be the bends - the guy was not down long enough". That may be perfectly true, but it could most certainly be gas embolism.

We do find a tremendous number of mixed cases in which both pulmonary barotrauma and decompression sickness are present in the same individual. It is really much more common than is recognised and I shall hypothesise about this a bit more later on. I would remind you that barotrauma and embolism can follow any dive. There is a habit in some dive teams for the dive masters to stay at the surface and snorkel down keeping their tanks ready for an emergency. I think this should be discouraged for I know of one fatality at least. This diving instructor went down to his scuba class and while he was down there took a puff from an octopus. He then forgot that he had taken a breath of compressed air and went back to being the snorkel diver that he had been all that morning. So he surfaced without breathing out at all and he was dead within a few seconds of reaching the surface. This happened in the Cayman Islands only a few months ago. Snorkel divers should really be discouraged from coming down and grabbing a mouthful of gas from a diver.

DECOMPRESSION SICKNESS

Decompression sickness requires a dive of sufficient depth and duration to take up a sufficient volume of gas which will cause bubble formation when you come up again. In pulmonary barotrauma, the bubble is alveolar gas whereas it is dissolved gas in decompression sickness. The damage begins during the decompression in barotrauma, whereas there is significant latent period in decompression sickness. The significant bubbles are intra-arterial in barotrauma and are intravascular, though everybody emphasises the intravenous bubbles, in decompression sickness. The effects are cranial, in air embolism, while in

decompression sickness, not only can you get cerebral effects, and some brain stem effects, but you get spinal cord manifestations. I know of no case of pulmonary barotrauma which has gone on to paraplegia. That is a dogmatic statement and I will stick with it.

Manifestations

The manifestations of decompression sickness, I mentioned latency, most things will happen inside twelve hours. If anybody comes to you with symptoms that started 36 hours after the dive, that is not decompression sickness. Bear in mind that I said onset. Divers may suppress manifestations and quite frequently do, but when you get an accurate history you will find that the trouble which they may not report for 48 hours after a dive, did in fact begin within that 36 hour latent period. I will try and stick with air diving, but you can well imagine in the deeper dives of professional divers the latency if often reduced to less than zero because problems occur actually during the ascent.

Perhaps we should touch on the causes of decompression sickness. I would just like to give you some thoughts. The first is failure to adhere to the tables. I think that is perhaps the most common. Many people do get away with it. It is just like Russian Roulette, it may catch up with them after a while. This happens to the semi-professional diver, such as the abalone diver who has started work at the beginning of the season, picking up the shells at maybe 60 to 100 feet, fished it out, and then gradually during the season works down to 120 to 150 feet. This is normal seasonal practice in this type of semi-professional. The trouble comes when the man, for some reason, takes a few weeks off in the middle of the season. When he goes back to work he gets a spinal hit on his first dive, back at 140 feet. I have seen two cases like this. The reason for this is the adaptation of divers who dive every day develop to decompression sickness. It may be that you get the gas nuclei all being used up or something like that, but let us just put it down as. being a phenomenon that exists. These people may get away with ignoring a diving table. The most common cause nevertheless is failure to adhere to the existing tables. I think the US Navy air tables are as good as any. However I prefer the Royal Navy tables because they are about 5 minutes more conservative on most bottom times. Really it is the Jesus factor that counts when you are working out the table. How accurately you have estimated the depth. Do you take the next deepest depth and the next bottom time? It is these things that make the tables safe. Certainly if you dive the 180 feet for 20 minutes table exactly to 179 feet for 19 minutes you will get a percentage of bends in the diving population. There is no doubt about that because we did it. So the tables are not intrinsically safe. But they are safe as normally dived by the normal kind of diver.

The second cause of decompression sickness is inadequate tables. That does not apply to people like yourselves and we are really thinking here of Helium bounce diving, where there are a lot of lousy tables. There is really no excuse for people diving using compressed air not to use competent tables, if they use any.

So it is the third cause that I will bring to your attention, individual idiosyncrasy. We can think of the common things such as obesity and all those other things which might well affect gas uptake and elimination. But there is no doubt that the normal Gaussian distribution applies to divers as well as to everyone else. There are people who can do 100 foot dives and come to the surface with no problems. However, I have seen a knee bend occur after a dive to 100 feet for four minutes and respond to treatment. So individual idiosyncrasy can be extreme. The mere fact that a guy has adhered to the table does not mean a thing. If he has got the symptoms of the bends, he has got bent, because he has been under pressure.

To sum up the three common causes of decompression sickness are:

1. Failure to adhere to diving tables.

2. Inadequate tables (usually helium bounce diving tables).

3. Individual idiosyncrasy.

Two less common causes are:-

4. Flying, or ascending to altitude on land, after diving.

5. Diving in mountain lakes.

Presentation

As I said right at the beginning, the classification of decompression sickness into mild and serious can be misleading. If you look at the work which Tony Slark did in the Royal Navy and has also been done by Rivera in the USN, reviewing the presentations of decompression sickness, you will find that a significant percentage of cases present with a limb bend, because that is the most excruciating manifestation. They have in fact got a more serious manifestation, and therefore do in fact belong to the serious category notwithstanding the fact the presenting symptom is a limb bend. In the UK, or rather in the North Sea, we now tend to say that all presentations of decompression sickness should be regarded as an emergency. Just to make sure we are not missing anything, we like to treat everybody, even the simple limb bends, as though they were a serious case of decompression sickness. Because it is far better to give people a table 6 and be confident rather than give people a shorter table and treat them inadequately.

There are various presentations of the so-called minor cases, some of which do not require treatment, which I think can be regarded as warning signs. Anorexia, fatigue and malaise are very significant as warning manifestations of the onset of decompression sickness. Fatigue in the legs is well described. Any diver who, when back on the

surface, gets anorexic must be observed very, very carefully. The “niggle” is another term that we use in Europe, the Americans have adopted it and given it a slight difference in definition. We used to say that a niggle is a limb pain that starts but within ten minutes is already beginning to get better. That is a warning that something else may well happen. If you do not know where the nearest chamber is then you had better find out. On the whole, providing the manifestations start to get better and then disappear altogether within ten minutes, you can regard a niggle as a narrow miss.

Limb bends have been sufficiently well described in the past. Just to refresh your memory, the pains are in or around the joints. They can be in the end of one of the long bones, it does not have to be necessarily in the actual joint line. They can be just a niggling sort of pain or they can be agonising. They can be rending pains with the diver rolling around in agony. Then of course the diagnosis is very easy. One person, who had had osteomyelitis in one limb, got decompression sickness pains in the other limb at a later date, and said the two were surprisingly similar. Of course, unless you have had osteomyelitis yourself that does not really help. The synovial joints are the ones that are affected. I think that every single synovial joint except perhaps the temporo-mandibular joint, has been described as the site of pain, certainly joint pain in the sterno-cervicular joint and the joints of the hand are not at all uncommon, even in the small joints of the feet. There is diminished movement. There may be paraesthesia. If you compress the site there may be a local response to pressure, which is quite useful as a diagnostic point. The pain may flit from joint to joint. It may be in the shoulder for a while and then in the knee. You have got to watch these people very, very carefully. But although you may get occasional redness and oedema over a joint, most commonly there are absolutely no physical signs whatsoever. The next important little statement is that if the diver says he has got pain in the knee, it does not matter what the examination reveals, that diver has got decompression sickness until proved otherwise. As far as I am concerned, proved otherwise means treatment by recompression. No physical signs are required for the diagnosis.

A typical cutaneous manifestation of decompression sickness is purple blotching, a sort of venous stasis which occurs in the skin. It does not require treatment per se, but nevertheless does respond to treatment if treatment is given. One should not confuse this with suit squeeze. There is an increasing tendency in the colder climates now to use dry suits. Unless the dry suit is fitted with a suit inflation valve then you get pinching and nipping of the skin by the dry suit, which is a very painful cutaneous condition which should not be confused with the cutaneous manifestation of decompression sickness. There are some more unusual forms of decompression sickness which are not very often seen. One is pitting oedema of the hand which is completely painless. It is thought to be due to the formation of bubbles in the lymphatics. If you believe Guyton’s hypothesis of the formation of the lymphatic fluid, the lymphatics have got the lowest tension of all the vessels in the body, and so a priori the lymphatics would be a place where bubbles form. Therefore in some individuals the bubbles will get dammed and you get lymphatic oedema. Another is pitting oedema of the lower part of the chest wall and other parts of the body. One diver was actually diagnosed as having mumps. He thought it was rather curious that he should suddenly get mumps just 20 minutes after surfacing from a dive, so he went to another doctor who made the diagnosis of decompression sickness, because on the whole, mumps does not fit.

The serious manifestations of decompression sickness are neurological and spinal. I think it is worth repeating that the most common onset is that the diver says that he has got a few pins and needles in one foot or a cottonwool feeling. A feeling that then ascends all too rapidly to become paraplegia. This is the commonest presentation of spinal decompression and one which I think is fairly ominous. But of course there are many, many others. So far as the spinal cord lesions are concerned I think that the worst situation that you can be in, is with the man whose paraplegia extends to quadriplegia and he is just left with the phrenic nerve pumping away. At that particular time you wish you had taken up some other specialty.

Labyrinthine decompression sickness or the staggers, has a very dramatic onset. It occurs particularly after rapid ascent, with nausea, vomiting, nystagmus and possibly tinnitus.

Cerebral symptoms include dysarthria, visual manifestations and changes in personality. Changes of personality are very, very difficult to diagnose. Although it is easy to say at a lecture that if a diver changes his personality after a dive he should be recompressed, in fact you usually find that the guy is being recompressed with reluctance and possibly for some other reason. It is only after the recompression you suddenly realise that the man has flipped back to normal and how very abnormal his behaviour was before the recompression. It is something to watch for and it is where the diver’s buddies are going to be very useful in assisting to make the diagnosis.

The pathognomonic sign in the respiratory manifestations of decompression sickness is the retro-sternal catch on trying to take a deep breath. It is best seen in divers who smoke, because they come out of the water, light up a smoke, take a deep breath and catch their breath because of the retro-sternal pain. If it is left untreated shallow, rapid respiration, pallor and shock develop. Shock is not a presenting manifestation. It tends to be rather overlooked and it is most common in cases which have been maltreated elsewhere. As a result they develop a postural hypotension associated with significant haemo-concentration. This used to be a presentation of decompression sickness in aviators too, until they discovered that it was not illegal for aviators to have decompression sickness.

Once it was quite a respectable illness, the aviators started reporting limb bends as well as collapsing after high altitude runs. If you read some of the older text books they mention shock as being a presenting symptom of decompression sickness. In my view, it is not a presenting manifestation. However you will find haemo-concentration very early on and even with limb bends.

Diagnosis

The investigations that one should make before coming to a diagnosis are quite simple, zero. My background is naval and commercial. As far as I am concerned, if a diver has the symptoms of decompression sickness I put him into the chamber, recompress him and examine him at depth to see if anything is left. With luck, there is not anything left. As far as I am concerned any delay of treatment, even to examine the patient, makes the treatment less likely to succeed. In my opinion it is good management to make the presumptive diagnosis on the symptoms, recompress the patient and then examine at maximum depth to make certain that the treatment has been effective. Jefferson Davis does not agree with this approach because he sees a different type of diving accident. I see divers who are diving close to a chamber so we can virtually get a 100% response even with rapid onset decompression sickness. In sports diving you have the problem of delay, which can be 5 to 36 hours after the onset of symptoms before they come for treatment. Under these circumstances it is reasonable to conduct a fairly rapid but meticulous neurological examination to obtain a good base line for judging progress so allowing better management of the case, but also it is much more allowable to commence ancillary treatment. It is much easier to put up a drip and put in a catheter before putting the patient into the chamber, rather than struggling with these in the confines of the chamber. But nevertheless the important message to take home is that you do not have to examine the patient, and even if you do examine the patient, you do not have to find anything wrong with him, to come to the conclusion that decompression sickness exists. The symptoms are sufficient, the feeling of numbness, the feeling of cottonwool feet, the feeling of pain in the limbs, the feeling of difficulty of deep breathing, all these require treatment as a medical emergency. That is the take-home message.

Pathophysiology

Let us consider the concept of decompression sickness. The old idea was that a safe dive was one during which no bubbles occurred. If you got bubbles, then you got the bends. Now we all know that is absolute rubbish. The Doppler Bubble Detector will detect bubbles in lots and lots of people who make a perfectly safe dive and never have any trouble at all. So we have quite a large overlap of bubbles occurring in safe dives. I think it is true to say that there are no dives that result in decompression sickness in which bubbling does not occur, although there are reports of this in animal experimentation.

Where do the bubbles begin? I have already mentioned the extravascular bubbles in the lymphatics. Catchpole and Girsch showed bubbles occurring in various extravascular tissues such as myelin sheaths which I think are important as possible causes of spinal decompression sickness. Extravascular bubbles occur in the fatty tissues of the body, particularly in the bone marrow and perhaps then the gas bursting out of these fatty tissues into the capillary bed and into the veins. What we normally notice first are the venous bubbles. Venous bubbles on the whole are filtered out by the pulmonary bed. Just occasionally a few might get through to the arterial side. We also know that arterial bubbles get through the systemic capillary bed very easily and will go through the venous side. It is generally agreed in the old text books that the pain of decompression sickness is due to bubbles and that all the other manifestations are due to bubbles acting as little plugs in the blood vessels so causing all the manifestations of decompression sickness.

I think the story is significantly modified now. It is important to recognise also that arterial gas emboli may occur in decompression sickness. I would like to stress this point because people who have not read the papers by John Hallenbeck and myself, assume that our hypothesis of venous infarction of the spinal cord is exclusive. It is merely an hypothesis for one mechanism of spinal cord decompression sickness. It is not exclusive. I think the final pathology can be a single end result of one or more pathogenetic pathways, of which arterial gas embolism is one. The original Haldanian hypothesis that gas embolism to the fatty myelin rich parts of the cord causes spinal cord decompression sickness can not be excluded. We think there are at least two other hypotheses which are more likely, one being the venous hypothesis and the other being the one which Brian Hills and Phillip James have re-emphasised recently, the formation of bubbles de novo in the myelin tissues of the spinal cord.

Bubble surface activity is pretty well known. It is mostly known from open heart surgery days and bubble oxygenators. A lot of work has been done to demonstrate the mechanism of the blood-gas interface in causing various changes. These are all proven effects. The activation of the Hageman factor is not only responsible for the cascade part of the blood coagulation cycle, but is also responsible for simulating a whole stack of other things, the release of various vaso-active substances and kinins and so forth. The activation of enzymes is another proven effect of the blood-gas interface. The de-naturation of proteins causes the red cell clumping which is well seen in decompression sickness. The rouleaux

phenomena has been described for more than 100 years now. The significant thing is platelet aggregation with the release of all the nasties the platelets have got stored within them. Already we are getting into a situation which is like a seamless web. A specialist in this particular field of haematology and blood-gas interface effects used the phrase "seamless web". I think it is a very good analogy. If you twang a spider's web in one part the whole web vibrates and you do not quite know which part of the web is going to shed the next drop of dew. This is also true of the blood system. Those of us who have worked in this field realise that Mother Nature has not got just one card up her sleeve but an infinite number. It does not matter how we play with the system, whatever therapeutic effect you put into an experimental decompression model, there is always some other pathway out of which comes a counter-effect which can nullify what we are trying to do. So it is an extremely complex situation.

Finally, and quite separately, the denaturation of lipo-proteins. I have kept that separate, because the lipid emboli that are formed as a result of that particular blood-gas interface effect do not have any other ramifications in haematology, they merely float around the blood stream and can cause various effects as emboli. They are frequently found in the autopsies of divers.

Here is a working hypothesis of decompression sickness which I think is quite useful. We have the so-called silent intravenous bubble, silent because there are no outward manifestations of decompression sickness. However, they can be detected by Doppler. The silent bubbles cause cellular aggregation of red cells and platelets, the release of kinins and other vaso-active compounds and the formation of lipid emboli. These cause a subclinical pulmonary embolism with tachypnoea, fatigue and malaise. That has been well established as being due to a sub-clinical pulmonary oedema.

We now get into an area of dispute. Vasospasm and bronchospasm lead to the severe pulmonary distress of the chokes, I think that is well established. But then it is suggested that the pulmonary congestion back pressures the vertebral venous plexus and causes spinal decompression sickness. The only point to make at this stage is that the hypothesis of venous infarction of the spinal cord does not depend upon the pulmonary part of that story to exist. It exists as its own entity as far as pathogenesis in concerned.

Studies in splenectomized dogs, using radio-active labelled albumin, show no change in plasma volume in "no-decompression" dives. After a dive in which severe chokes and paresis occurred there was evidence of loss of circulating protein into the tissues, of the formation of oedema, and of haemoconcentration.

In the chamber at Duke University in which we did this work we had an X-ray machine that was pressure proof. We could take it into the chamber and take it down to 300 feet. In fact, we only took it to 155 feet. Besides taking X-rays of the vertebral venous plexus we exposed the spinal cords of the dogs and made movies of the vertebral venous plexus during the dives. Quite definite congestion occurs after a dive. In one slide the congestion has even filled up one of the spinous process veins. In another slide the bubbles can be seen along the vertebral venous plexus. Just looking at the vertebra you can see it is almost as though it has been cleaned out, there is not a blood vessel to be seen in that area, although in the pre-dive slide of the same orientation we could see the vertebral venous plexus very well. What we are really saying is that in this particular experimental model, the vertebral venous plexus just gets wiped out with bubbles.

Using a C-14 pyrene technique one can measure instantaneous blood flows, but only once, as you have to kill the dog to do in millilitres perfusion per 100 gms of tissue. Using this technique one can show a normal flow in a normal spinal cord, but after the onset of paretic decompression sickness there are areas of virtually no flow.

Histology

In paretic decompression sickness there are, besides haemorrhagic areas, vacuolations in the myelin. This we can consider as being due to bubble formation in the myelin sheaths. There are two hypotheses as to why this should occur. One is that the bubbles will form there de novo anyway, and the second, and separate one, is that they form there as a result of venous slowing and stasis, the damming up of the circulation. The only difference is that in the venous infarction of the spinal cord hypothesis, which wipes out whole levels of the spinal cord at once, the stasis of the venous system for more than a silicone clotting time allows clot formation to occur in the smaller vessels of the cord. This obviously is bad news so far as the owner of the cord is concerned. In all our slides from paretic animals there are areas of haemorrhage and bubbles in the myelin.

We consider that there is sufficient pathology just with the vascular effects, the formation of clots, the damming back of the blood flow in the capillaries, to explain the histology.

The third hypothesis is based on the fact that although the spinal cord is soft, flexible tissue, it is not very expansile. Therefore the formation of gas in the myelin increases the internal tension within that segment of the cord. The increased tension will squeeze out all the blood from that particular part of the cord and cause spinal decompression sickness. That is a perfectly acceptable alternative hypothesis. The work on that is not yet complete.

We have got three aetiologies for spinal cord decompression sickness to consider arterial gas embolism, venous infarction and in-situ bubble formation. John Hallenbeck and I

consider this to be a secondary effect to the fact that clots were forming in the venous system. It is obvious that the pathology is the same. It is only that the explanations are at variance.

We have a scanning electron micrograph that we did showing one of the vessels of a nerve root very close to the spinal cord. Using increasing magnifications you can see strands of fibrin and red cells on the side wall of that vessel, which is quite positive evidence that it is a pre-mortem clot. We feel confident that we demonstrated in that animal that there was venous clotting and that venous infarction of the cord was the cause of that particular animal's paralysis.

We have covered the sorts of things that are going on at the time when the diver is saying "Please doc, my feet are going numb". The take home message is that it is not just a question of bubbles getting stuck in the spinal cord, there is a whole lot of other pathology going on and that it is very much more complex than anybody would care to claim to understand.

John Hallenbeck and I did this work about ten years ago. I quit about five years ago. He is now working not so much on spinal cord decompression sickness, but on cerebral gas embolism. I particularly commend to you the edition of Stroke of December, 1979. He has not published anything in an easily accessible journals since then. He has been working on the effects of gas embolism to the brain. What he was concerned about was the fact that once you stop the brain's circulation there is no recovery. The majority of people still say that after four minutes the brain is dead and there is nothing you can do to restore circulation. I am pleased to say that John Hallenbeck's work has shown that to be a load of rubbish. In essence what he has done is to examine the various factors which are responsible for the so-called "no reflow phenomenon". Even if you restore the blood pressure and remove the embolus, you cannot restore the circulation to that particular part of the brain that suffered ischaemia. He has demonstrated that there are various endothelial and other factors which contribute to the "no reflow phenomenon". He reported in this particular paper that he gets a 65% recovery of function in animals which otherwise would have made no recovery at all by the use of prostaglandin and indomethacin. He made a superb presentation only about four weeks ago on this. This is work that is still going on, demonstrating that there is some hope that in those divers who get gas embolism we will perhaps be able to prescribe some medication which may help to restore function. I had John Hallenbeck come over and present his paper just a year ago to the Institute of Neurology at Queen's Square. It was one of those electric occasions when the audience is all a little bit bored and shuffly, and suddenly you could just feel everybody stop and pay attention to what John Hallenbeck was saying. It was a tremendous occasion. The work is continuing at Bethesda and it is well worth keeping in mind not only for gas embolism cases, but also it may well have an application in cases of embolic stroke and so forth.

DISCUSSION

Chairman: Dr John Knight

You did not mention rapid ascent as being a common cause of the onset of decompression sickness. Certainly in the cases which are treated in Sydney and the cases that occur at Nauru, it is a very common cause. Some of these are inside the tables but they have all shot to the surface, having run out of air, or seen a shark, and need treatment. A mild example is a friend of mine who was diving in Portsea Hole with four friends when he saw the anchor of his boat go past. He was at 80 feet. You can only dive there at slack water, so he was after the boat like a rocket. His knee started to hurt about two hours later and it went away after about three days. He did not bother the doctor in the interval.

Dr David Elliott

From an academic point of view I am delighted to hear this. I am sorry for the guys, but this in fact is what I was implying when I said let us not be dogmatic and divide decompression disorders into the two principal extremes. There are obviously mixed cases. By that I mean that we have got quite a lot of cases on file now of people who should have been pulmonary barotrauma or might have actually produced pulmonary barotrauma, and who then developed decompression sickness. They should not have really had decompression sickness at all because their dive was perfectly safe.

In my own courses we do a tremendous lot of case history discussions. I think that they are a really important part of that kind of meeting. The case which I will now present has just made me think of one other aspect of decompression sickness, that I have not stressed at this particular meeting.

A diver was at about 50 feet, playing with one of those research submarines in Jamaica. He had been down 50 minutes or so at 50 feet, certainly well within the non-stop times, and made a rapid ascent. Within half an hour he had a classic onset of decompression sickness. I think that is the sort of example that you could be talking about.

This particular guy gets rather quadriplegic, so how about recompression? That particular island in the Caribbean does not have a chamber. So they shipped him to a recompression chamber. I hasten to add that the chamber was not the British Sub-Aqua Club chamber at Cayman Island, but a chamber on another island. It was run by a Navy and not, I hasten to add, the Royal Navy. It was run by a Navy which shall remain anonymous. This poor quadriplegic was treated quite correctly by recompression. However the physicians had not been properly trained in diving medicine. They were very concerned about this paralysed

diver, because he had an acute abdomen. So they brought him to the surface and they opened him up. What do you think they found? He had a catheter in so it was not a full bladder. They found that he had a paralytic ileus. Not very surprising really. So they sewed him up again, and he continued to be a quadriplegic with a burst abdomen. That went on for a long time. You will be pleased to know that he is wandering around on sticks now.

He was a classic case of a mixed presentation. The guy who rushes to the surface after 50 minutes at 50 feet, expected to be the classic gas embolism presentation, yet he showed classic decompression sickness.

Dennis Walder was the person who first put forward some kind of an hypothesis for this. I gave him credit for this hypothesis in a paper, and when I told him he said "That is not what I meant at all". He suggested that in some alveoli there might be air trapping which might cause micro-barotrauma. That some of the smaller alveoli might well distend with gas during ascent and blip off bubbles into the pulmonary venous system. These bubbles could seed and as they went through areas of high inert gas loading, those bubbles would grow producing decompression sickness.

Remembering that there are a lot of people who do a rapid ascent and produce sub-clinical EEG signs or mediastinal emphysema from decompression barotrauma, it is a perfectly reasonable working hypothesis that a person can come rapidly to the surface, discharge into his bloodstream a shower of small bubbles, which really do not matter a damn. Except in those individuals whose tissues are already loaded with gas. They are within a no-stop time, but they have got a fair load of nitrogen in their system. The bubbles and the inert gas load act synergistically to produce decompression sickness in the person who has made a rapid ascent.

Chairman: Dr John Knight

What you have been saying confirms what John Miller was saying to us last year that the people that he gets from the Caribbean usually have a combination of illnesses. It also confirms that if you really look for neurological signs you can often find them.

Question: Dr Bob Hare

I would like to ask a couple of questions about buoyant ascent. Firstly, I am curious to know whether, when you are breathing out for something like a minute and a half ascending from 100 feet, you get a desire to take a breath in. Secondly, could airway collapse be prevented by breathing out against resistance through pursed lips, in much the same way as someone with emphysema does.

Dr David Elliott

To take the second question first. The answer is yes. If you can make the pressure gradient less, by breathing out through pursed lips, maybe that would help, because it is an equal pressure point down the airway which causes the trouble. There is no problem in regard to your first question, in fact as one comes up exhaling, one is just washing CO_2 out.

Buoyant ascent to me is an ascent at approximately 6 to 8 feet per second, when you are in fact using positive buoyancy. Free ascent is not a term that I personally use in association with diving. A free ascent is really confined to a submarine escape training tank. A person who is breathing compressed air at depth from an air lock, who then uses for buoyancy merely his expanded chest containing compressed gas. That is a highly specialised method of ascent. Because you have taken a breath of compressed gas at depth, you have got no gear on, so the only buoyancy that you have got is a full set of lungs. You have got to use your full set of lungs to get your body back to the surface and yet you have got to blow out enough so as not to burst your lungs. That is free ascent. When I did it, I blew out too much and became negatively buoyant. Once you are negatively buoyant you can only go down.

Question: Dr Bob Hare

Say you are scuba diving at 100 feet, and something goes wrong and you wish to go up to the surface faster than usual. Theoretically you should take a minute and a half to do that, exhaling all the time. Does one get a desire to breathe in on the way up? If not it must mean that the stretch receptors must have a lot to do with the desire to breathe in.

Dr David Elliott

The answer to your final phrase is an absolute "YES". There is no doubt about it, the stretch receptors are very important. Without them snorkel diving would be a pain. As far as the minute and a half ascent from 100 feet goes, I see no problem. CO_2 washout is going to help you all the way. I would say once again that if you are having difficulty making it so slowly, flare everything. Make sure that your fins are at right angles to your legs.

Question: Dr Mike Page

During the first talk you showed slides where a diver's X-ray was normal before the ascent and after the ascent it had basal emphysematous bullae. Was that an expiratory film? Is it best to do an expiratory film in routine screening rather than normal inspiration chest X-rays?

Dr David Elliott

Dr John Harrison, who actually reported on those films, went through a phase of saying that every diver should really have an inspiratory and an expiratory film in order to detect bullae that would otherwise be hidden. On the very first one he picked up bullae that would otherwise have been hidden behind the heart. The guy was a professional instructor who had never had any kind of incident. I am

not quite sure whether it helped or not. The answer to your question is that if you really want to be meticulous, do both films.

Question: Dr Tony Slark

You did not mention DIC (Disseminated Intravascular Coagulation) at all. Is this the next thrilling installment?

Dr David Elliott

No, not at all. There was about seven or eight years ago lots of discussion as to whether or not the various effects of the blood gas interface would in fact cause DIC. The haematologists got to work and started looking for fibrin degradation products and doing all the other clever things that they do. The net result was that DIC as such does not exist in decompression sickness. We say quite specifically that intravascular coagulation does occur in decompression sickness. Therefore the word that we have to be a little bit semantic about is disseminated. We are really saying that it is only in those parts of the circulation where stasis occurs longer than a normal silicone clotting time that time the blood will coagulate.

Question: Dr Tony Slark

How then do you account for slides that you show and that others have shown many times in the past of extravascular clotting?

Dr David Elliott

Extravascular clotting? You mean haemorrhage. I would say that haemorrhage is a very common finding in the pathology of spinal cord decompression sickness. I would not like to guess at what actually causes the haemorrhage.

Chairman: Dr John Knight

About five years ago anaesthesia was besieged with cases of Disseminated Intravascular Coagulopathy. It occurred in everything. Over the past five years a certain amount of sanity has returned. Instead of saying that everybody, everytime anything happened to them got DIC that you could not detect unless you did very specialised blood tests, now we are accepting that DIC is in fact rare in ordinary human trauma.

Question: Dr Mike Ramsay

I would dispute that. What you are talking about is a condition, not a disease. A full blast DIC is as rare as hen's teeth I agree. Thank God you do not meet many of them.

I would like to know whether it is intravascular coagulopathy or intravascular coagulation. To me there is a difference. The first is a response to a stress. You looked at the dog's spinal cord. Did you examine its belly vasculature?

Dr David Elliott

No.

Question: Dr Mike Ramsay

Was the vascular status in the rest of the animal any different from that of the spinal cord?

Dr David Elliott

You mean did the animal have a Disseminated Intravascular Coagulation throughout its entire body? Is that your hypothesis? Then one would expect surely, that the animal would not only be suffering from a spinal cord lesion. The spinal cord manifestations are not a presentation of DIC. This was an animal which had done a pretty horrendous dive. It would have survived about three to five hours after the dive ended if it had not been sacrificed.

Question: Dr Janene Mannerheim

In the presentation of decompression sickness how common are limb bends that are not very painful? Is severe headache on its own ever a presentation?

Dr David Elliott

Both of these are good questions. I will deal with the limb bends first. The trouble about limb bends is that it is totally subjective. What the patient feels has to be interpreted by him and passed on to the doctor. If you put a novice diver in a team with experienced professional divers, you will find that the novice diver is always having pains here and there. Things that the experienced diver just accepts as part of his way of life. If you see a person doing a repetitive movement, without even being aware of it, keep an eye on him. Because maybe an hour or so later he is going to say that he has got pain. From my own experience I would not be surprised if one or two of you had not had similar feelings of discomfort. One is just not quite sure what it is.

Yes, headache is a presenting manifestation and it tends to be a migranous type of headache. The hypothesis (we are great on hypotheses, it is proving them that is difficult) for what it is worth, is that the platelets are all stirred up with the bubbles floating around. It is not unlike the mechanism of migraine. Those who dive who are migraine sufferers say that if they get a migraine following a dive, it is one hell of a migraine as opposed to a normal headache.

Question: Dr Peter James

Can the neurological signs of decompression sickness be transient? How should you act if they go away?

Dr David Elliott

Yes, the neurological manifestations can be transient, in fact if you go back to Paul Bert of one hundred years or so ago, before recompression was used for treatment, you will find that a large proportion of people got better without any treatment at all. The trouble is that in this modern day, when we have treatment, you can not predict which guy is going to be the one who gets better, and which is the guy who is going to get worse.

Question: Dr Peter James

This is an interesting point. I had one patient with slurred speech that lasted fifteen minutes and went away completely. The two chambers that I rang both said that he was not down long enough to be bent. He had dived within the no-decompression times.

Dr David Elliott

The thing about these people who do get better spontaneously and do not require treatment, for there is nothing to treat, is that they should be handled in the same way as a person who has been successfully treated. That is, they should be kept in the immediate vicinity of the chamber or got to the immediate vicinity of the chamber. Because there are plenty of people who have had such transient episodes, who maybe six hours later get a recurrence which was not so transient. I think those chambers made two mistakes.

Question: Dr John Knight

Do you expect somebody who presents with chokes twelve hours from a chamber, to be dead by the time he gets to the chamber? John Miller said last year that all untreated chokes were fatal, but I have met divers who have said that they have had the chokes and were not treated.

Dr David Elliott

It could be a very mild form of chokes. The chokes is a mass of venous gas emboli going to the lungs. I suppose there is no reason why they should not resolve normally and be a transient phenomenon just like anything else.

Dr Tony Slark

There is another answer and that is that the majority of people do not report minor chokes. It is not a problem so far as I can see with divers, though it may be with aviators. It is a very rare thing with divers and particularly with scuba divers.

Dr John Knight

Going on from that, two years ago I came up from a dive much faster than I normally do. About thirty seconds after I got to the surface I became extremely breathless. I also started to wheeze. I just could not control my respiration. There was no hope of me swapping to a snorkel. This lasted for about five minutes. I could not get myself into the boat. All I could do was to float in my compensator. I thought that I possibly had done what I saw in the abstracts of the UMS meeting, bubbled my blood on the way up and got a load of bubbles in my lungs. Thinking back on it, in the old text books of anaesthesia, in the days when they allowed spontaneous respiration for neurosurgery, one of the things that you were told was that if the respiratory rate suddenly increased, the patient had sucked air into a vein and developed gas embolism of the lung. I wondered whether you had had similar stories told to you, or had seen anything similar? Douglas Walker put it down to a tight wetsuit.

Dr David Elliott

No. I think it is because the population that we deal with do not do that kind of diving and so do not get that kind of problem.

Question: Dr George Thompson

I wonder whether David could speculate or tell us the mechanism of the feeling of impending blindness in gas embolism?

Dr David Elliott

In fact it is just that the guys feel that they are going blind and they do go blind. One can only assume that it is occipital or somewhere else on the visual pathway.

Question: Dr Terry McGrath

I know of a diver some time ago who went blind in one eye. He said it was like watching a television screen go off. Not being very experienced in this, I sent him off to an ophthalmologist who said that he had a retinal artery thrombosis. Slowly over the ensuing weeks his vision came back again.

Question: Unidentified Speaker

I have a question about micro-bubbles and rapid compression fracturing micro-bubbles.

Dr David Elliott

I think what you are referring to are micro-nuclei and the fact that if you compress sufficiently you will in fact re-dissolve the micro-nuclei. But this is the sort of thing you do with shrimps by banging them down to 1,500 feet in two seconds. It is not good for humans.

QUALIFICATIONS IN UNDERWATER MEDICINE

Department of Defence (Navy Office)
Campbell Park 4-7

10th November 1981

The Secretary,
South Pacific Underwater Medicine Society.

POST-GRADUATE QUALIFICATION IN UNDERWATER MEDICINE - POLICY STATEMENT

1. Naval policy in respect of a postgraduate qualification in underwater medicine is as follows:

   a. The RAN School of Underwater Medicine (SUM) is responsible for recommending to the Director of Naval Training the names of those candidates selected for Underwater Medicine Courses.

   b. Priority for placement on Underwater Medicine courses is to be afforded as follows:

   (1) Serving Medical Officers
   (2) Reserve Medical Officers
   (3) Sponsored Government Medical Officers.
   (4) Others - depending on justification and vacancies.

   In respect of those described at sub-paragraph b (4) above, only those with an expressed interest in proceeding to civilian academic certification should be accepted.

   c. The Underwater Medicine syllabus is to be developed and maintained by the RAN SUM with Navy Office acting as approving authority for Service certification and the Commonwealth Institute of Health (CIH) acting as approving authority for civilian accreditation. Navy Office and CIH should liaise with respect to course content and should remain receptive to suggestions from the RAN SUM and the South Pacific Underwater Medicine Society (SPUMS) for updating of course content in the light of new advances in this field.

   d. The examination committee for civilian academic certification purposes is to be nominated by CIH as the approving authority. However, should CIH see fit, there is no objection to nominations for this committee being enlisted from the RAN and/or SPUMS.

   e. The RAN SUM is the sole authority for certifying the standards achieved by Service candidates for the practise of this specialty within the Service environment. However, CIH will be the approving authority for those candidates who are presenting for civilian academic certification (tentatively titled 'Medical Examiner of Underwater and Hyperbaric Workers') by the CIH.

BT Treloar
Surgeon Rear Admiral, RAN
Director General of Naval Health Services

NO NEED FOR CROCODILE TEARS

The threat to the-continued existence of crocodiles in the northern part of Australia, a result of increasing human habitation and the value of their skins in the fashion market, has been contained. They are said to be the closest surviving relatives of the dinosaurs and have been a fantastically successful species in evolutionary terms. But they have never aspired to become popular or cuddly even in the estimation of their closest admirers and are said to willingly bite the hand that tries to feed them from the moment of hatching. Zoologists admit that their studies have to be limited to the baby and juvenile stages because the adults are "fairly difficult to work with". The fact that crocodiles seem to have a potential to live for 100 years gives them another edge over mere human observers.

Their ability to live in a salt water environment without kidney or other damage remained a puzzle until Taplin and Grigg discovered that they had salt excretory glands on their tongues, a site not initially suspected by researchers. Most animals faced with an excess salt problem have such glands associated with their eyes or their nasal passages. The crocodile's habit of remaining largely submerged, allowing a flow of water through the incompletely closed mouth, ensures that the brine solution is washed away. Their ability to remain submerged is not, apparently, due to a "dive reflex" but rather to low metabolic demands on their aerobic system. Forced diving, ie. if they are held down and struggling, reduces their submersion time below 15 minutes. As they kill by a combination of violent shaking of their victim plus submersion, such breathholding times are fully adequate.

Because of their Protected Species status, commercial breeding has been started in the Darwin area. Malcolm Eardley, a pioneer in this activity, started the venture to "recycle" his hens when their egg laying fell off. The parent stock of crocodiles was taken from the wild and therefore remains protected, but the crops of young are "harvested" when they reach a size suitable for handbags or other souvenirs. There is always a bill for free lunches! Though tough when adult, they are not reared without trouble. It was found that the little crocs were dying though fed well on chickens and the cause was ultimately identified as the over fatty nature of the chickens. So for the first six months the crocs are fed ground buffalo, fish or wallaby and have their teeth brushed with a fluoride toothpaste.
The Official posture concerning the crocodile population has, of necessity, to be somewhat left hand/right hand separately operating.

The Tourist Commission has reasoned that "People go to Africa to see man-eating tigers. It's one of the country's main attractions. In the Territory we have the only man-eating beast in Australia. Why shouldn't we promote it?" So they have painted large green crocodiles on several tourism promotion buses in Sydney. Meanwhile, in the Northern Territory the Conservation Commission have the difficult job of trying to ensure that neither the crocodiles nor the local population come to harm. They hardly desire large numbers of adult crocodiles around the tourist beaches, whatever the Tourism promoters may think of the Authentic Local Colour this would add to any holiday. Although there have been only three fatalities (one a diver) and three serious other incidents in the NT in the last three years, any attack is bad news to those involved. Attacks also occur in north Queensland and Western Australia. So the Conservation Commission has initiated a phone-in "dob-the-croc" 24 hour service and undertake a search-and-relocate exercise for those noted in areas frequented by numbers of people.

Crocodiles are the largest terrestrial predator in Australia and if they were removed, the whole balance of things right down the line would be shifted in an unpredictable manner. Relatively little is known about them, so wildlife rangers in Queensland are to be given courses on the preservation of crocodiles and wildlife rangers. They are being taught how to tell the "good" from the "baddy" crocodiles, how old they are, how large they are likely to grow, how to catch and remove them if required, and to find out what they like to eat. It is hoped, for the sake of all concerned, that the answer will not be "people".

SYDNEY MEETING
Saturday 20th March 1982

A meeting of the South Pacific Underwater Medicine Society will be held on Saturday 20th March, 1982 at HMAS PENGUIN. The venue will be the conference room of the Naval Staff College.

The organiser is Dr Peter Sullivan, the Officer in charge of the RAN School of Underwater Medicine, telephone 02-690 0333. (Naval working hours 0800-1200, 1300-1600). Intending speakers are requested to contact him as soon as possible.

SUBSCRIPTIONS

Members pay $20.00 yearly and Associate Members $15.00. Associate Membership is available to those neither medically qualified nor engaged in hyperbaric or underwater related research. Membership entitles attendance at meetings and the. Annual Scientific Conference and receipt of the Journal/Newsletter. Anyone interested in joining SPUMS should write to the Secretary of SPUMS, Dr Christopher J Lourey, 43 Canadian Bay Road, Mount Eliza VIC 3930.

UNDERSEA MEDICAL SOCIETY 1982 ANNUAL MEETING

This will be held in Norfolk, Virginia, from 4th to 6th June 1982. The programme will consist of a Symposium on Diving Safety, some tutorials, oral sessions, posters and a poster symposium. Dr John Miller, the SPUMS guest speaker in 1980, is once again the Programme Committee Chairman. The last time he had this position was for the 1979 meeting in Miami which was a great success. He is hoping to involve the Cousteau Society and the South East Consortium for Undersea Research with their research ship.

Dr Miller also hopes to have a special section for associate members covering technical aspects of chamber and diving systems, hyperbaric nurses and off-shore communications.

7TH ANNUAL CONFERENCE ON THE CLINICAL APPLICATION OF HYPERBARIC OXYGEN

To be held 9-11 June 1982 at the

DISNEYLAND HOTEL
Anaheim, California

Plenary Sessions on Use of HBO in Neurological Disorders and Anaerobic Infections.

For more information, contact:
Baromedical Department Memorial Hospital
Medical Center
2801 Atlantic Avenue,
Long Beach, CA 90801-1428

NOTES TO CORRESPONDENTS AND AUTHORS

Please type all correspondence, in double spacing and only on one side of the paper, and be certain to give your name and address even though they may not be for publication.

Authors are requested to be considerate of the limited facilities for the redrawing of tables, graphs or illustrations and should provide these in a presentation suitable for photo-reduction direct. Books, journals, notices of symposia etc., will be given consideration for notice in this journal.

REPRINTING OF ARTICLES

Permission to reprint articles from this journal will be granted on application to the Editor in the case of original contributions. Papers that are here reprinted from another (stated) source require direct application to the original publisher, this being the condition of publication in the SPUMS Journal.

Address correspondence to:

Dr Douglas Walker,
Editor, SPUMS,
PO Box 120,
NARRABEEN NSW 2101

SPUMS ANNUAL SCIENTIFIC MEETING 1982

Place: MADANG RESORT HOTEL
Madang,
Papua New Guinea

Dates: June 26th to July 5th

Main Topic: FITNESS TO DIVE

Guest Speaker: Dr A.A.(Fred)Bove

Organiser: Dr John Knight,
80 Wellington Parade,
East Melbourne VIC 3002

Travel Agents: Allways Travel,
168 High Street,
Ashburton VIC 3147
Tel: 03-25 8818
(Reverse charges)

The Committee of SPUMS has chosen a beautiful site for the meeting. The diving is excellent. The guest speaker, Dr Fred Bove, will be lecturing on the following topics:

- A basis for drug therapy in decompression sickness
- Strategies for treatment of decompression sickness when no chamber is available
- Exercise physiology
- Fitness for diving:
- Cardiovascular disorders and diving
- Pulmonary disorders and diving
- Other medical problems and diving.

Dr Bove is well qualified to educate SPUMS members as he is not only a cardiologist who is also a diving instructor but also the Chairman of the Education Committee of the Undersea Medical Society. His research projects have included working with David Elliott and John Hallenbeck elucidating the part venous stasis plays in the production of spinal decompression sickness.

The Committee hopes that the meeting will be able to produce, or at least start the process of producing, a statement on the minimum standards of physical fitness required for Australian sports diver trainees. That this is necessary was shown by the letter from the FAUI National executive published in the last issue of the Journal. The relevant chapter in the Second Edition of “Diving and Subaquatic Medicine” by Edmonds, Lowry and Pennefather, with this and the last issue of the Journal, will help members prepare their contributions to the discussions.

That is not to say that there is no place for papers on other topics of underwater and surface interest at this meeting. Already papers on drowning, ENT problems and dysbaric osteonecrosis have been offered. Produce your paper and get your name in print.

EXECUTIVE COMMITTEE OF SPUMS

Nominations are required for the following positions:

- President
- Secretary
- Treasurer
- Editor
- Three committee members

Nominations signed by the nominee, the proposer and the seconder must be in the hands of the Secretary by 15TH MAY 1982. His address is:

Dr CJ Lourey,
43 Canadian Bay Road,
Mt Eliza, Victoria, 3930

By the President:

Dr Lourey will not be standing for Secretary. The Society needs an energetic member, who is willing to devote about three hours a week to the Society’s business, to succeed him. SPUMS is your Society. Its continuance depends on your activity. Volunteer for office and help sustain SPUMS and increase its influence and effectiveness.

John Knight

COURSES IN UNDERWATER MEDICINE

The RAN School of Underwater Medicine will be running courses in underwater medicine in September 1982.

The basic course will run from 6th to 17th September.

The advanced course will run from 20th to October 1st September.

There is no charge for the course. However, the RAN cannot provide accommodation for civilians.

Applications should be made in writing to:

OIC, RAN School of Underwater Medicine,
HMAS PENGUIN,
Balmoral Naval PO NSW 2091

Members’ attention is drawn to the RAN policy statement on postgraduate qualification in Underwater Medicine.

Applications should include details of medical qualifications, age, experience and the reasons for wishing to attend the course. Places in the courses will be allocated by the RAN. SPUMS no longer has any say in who does the course. So do not apply to the Secretary, SPUMS, write instead to OIC, RAN SUM.

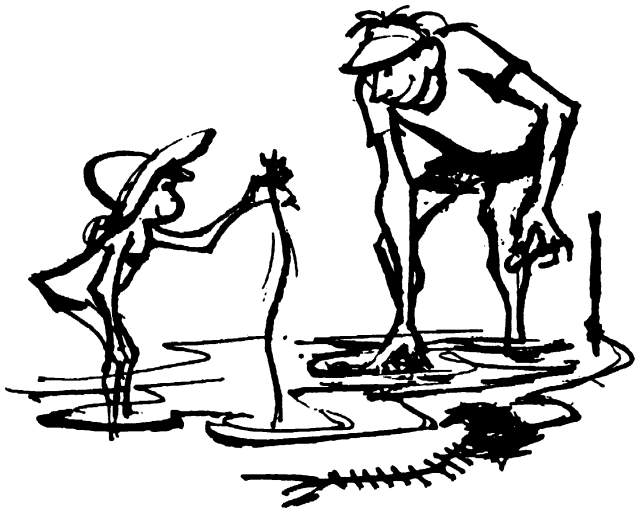
MASTER FISHERMEN OF THE QUEENSLAND BEACHES

The humble blood-worm, a popular bait for use by family fishing expeditions in Queensland, has recently been re-classified (promoted up the Evolutionary ladder?) as a "fish" under the Fisheries Act. This has, not surprisingly, little to do with the new Institute of Marine Science but a lot to do with the insatiable need for increased State tax income.

The State's Minister for Primary Industries has noted that the local worm digging had become Big Business in Queensland, sales being estimated at $2 million yearly. No Government likes to introduce new taxes visibly, so the simpler option was taken to call these sea-land dwellers "fish" and to apply already operative regulations. There was an outcry that this would effect many "battlers", the small-time entrepreneurs for so long involved in the bait-supply business. They would have been forced to register as Master Fishermen, become members of the Queensland Commercial Fishermen's Organisation, register their dinghies and pay a fee for each person digging. This was likely to cost a battler with an outboard dinghy $180 yearly in government charges.

The Minister replied that such people could take out a $10 licence as Assistant Fishermen and work for a commercial fisherman or a $40 licence as assistants (semi-Master Fishermen?).

There is no truth in the rumour that aviary keepers will have to register with the Department of Transport (Air) or that earthworm breeders are considering taking out Gun licences.



CAN I BE A MASTER FISHERMAN WHEN I GROW UP?

!! WARNING !! WHY TWO ALUMINIUM CYLINDERS EXPLODED IN THE USA

Early this year (1981) there were two incidents in Florida where aluminium cylinders exploded during filling in dive stores. In one of the stores the store owner and four customers were injured, in the other the store owner's son (who was filling the cylinder) had his legs blown off. In each case it was the first time the cylinder had been filled after being repainted or refinished at local paint stores, the method used involving high temperature "curing" of the paint.

Because of lack of proper control of the heat involved the cylinders may lose their temper. US Government regulations specify that aluminium cylinders subjected to the action of fire MUST be removed from service. The Compressed Gas Association (Pamphlet C-6.1) further specifies that an aluminium cylinder which has been exposed to more than 360°F SHALL BE CONDEMNED. Failure to adhere to these requirements could cause further tragic accidents due to cylinder metal failure.

It is suggested that before filling any cylinder the hydrostatic test date be checked to establish that it is more recent than any repainting by a method involving heating. A new hydrostatic test is essential BEFORE any such cylinder is filled with compressed air.

A STRIPED WET SUIT DISCOURAGES SHARKS .... PERHAPS

Question

On a TV program, it was stated that sharks fear the banded sea snake and that some divers have painted their wet suits to resemble this animal to ward off shark attacks. Is a striped wet suit actually an effective shark repellent?

Answer

Striped wet suits do tend to deter sharks from approaching divers but not for the reason stated. Sharks are not in fear of the banded sea snake and, in fact, actually prey upon it. The reason for the deterrent effect appears to be that sharks are frightened by the presence of a six to eight feet (with flippers) creature that is strongly and unusually coloured. This would also explain why Atlantic sharks, which never come into contact with sea snakes, avoid divers in striped wet suits.

The behaviour of sharks is not well understood, and so the above method of repelling them is not completely foolproof. It should be kept in mind that the individuals involved in testing the striped wet suits are experienced in diving in shark-infested waters and know how to avoid truly risky situations. For the majority of divers, the best way to avoid shark attack is simply not to dive in waters where these animals are seen. Illustrations of the sharks likely to be seen by divers are presented in *SHARKS AND OTHER DANGEROUS SEA CREATURES* by Idaz and Jerry Greenberg, 1981 (Planet Ocean Book and Gift Shop, International Oceanographic Foundation, 3979 Rickenbacker Causeway, Virginia Key, Miami, Florida 33149, USA).

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MINUTES OF THE EXECUTIVE MEETING

Held at 1030 hours on 17th October, 1981 at 8 Bembridge Avenue, Frankston.

PRESENT: J Knight, C Lourey, W Hurst, J McKee, J Doncaster, V Brand

APOLOGIES: D Walker

MINUTES OF PREVIOUS MEETING:

Read and accepted as correct.

BUSINESS ARISING:

A. Diving Emergency Notice:

Layout accepted. A copy of this will be included in the next Newsletter. It is to be circularized to all Public Hospitals in all States of Australia and New Zealand.

B. SPUMS is to apply for Associate Membership of the Australian Resuscitation Council.

CORRESPONDENCE:

Was received from the following:

1. Department of Health (Commonwealth Government) - refusing permission to publish the Draft Statement of needs of the "Diving Central Medical Registry".
2. Professional Divers Association of Australasia.
3. The President of the Undersea Medical Society - re SPUMS and UMS affiliation.
4. Dr Harry Oxer - re the WA Protocol for Diving Accidents.
5. Dr Jimmy How - re subscription rates in overseas countries.
6. Dr Norman McIver - re Flying after Diving Seminar in UK January 1982

BUSINESS ARISING FROM CORRESPONDENCE:

The Committee unanimously supported the affiliation with UMS. The cross-fertilization between the two Societies will bear many fruits.

Notice of the Flying after Diving Seminar in the UK in February 1982 is to be promulgated in the Journal. Representation from SPUMS is invited. Any SPUMS Member who will be in the UK at this time and who would like to attend is requested to contact the Secretary of SPUMS.

TREASURER'S REPORT

Current cash in the Bank at 25th September 1981 - $7,189.00. The investment accounts are unchanged from the Auditor's Report dated 30th April, 1981.

PRESIDENT'S REPORT

The 1982 AGM/Scientific Meeting is to be held in Madang - Papua New Guinea. The official dates are 26th June to 6th July 1982.

The Guest Speaker/Keynote Lecturer is Dr Alfred Bove. The general theme of this meeting will be "Fitness to Dive".

SECRETARY'S REPORT

The Secretary reported the current activities of the Society in supporting the establishment of the Central Medical Registry. The situation at present is that the Minister of Health is examining the evidence before him!

NEWSLETTER

The July-September Issue of the Journal is now at the Printers. The next issue will be the December quarter Journal. The Special Symposium Issue will be published in December also.

As listed separately (not printed).

FUTURE MEETINGS

(1) Western Australia - 12th December 1981 at the Mt Lawley College of Advanced Education.

(2) It is hoped to have a Meeting at the School of Underwater Medicine in March 1982.

(3) Venues for the 1983 AGM were discussed - two sites for close investigation are Guadalcanal and Tahiti. The Secretary is to investigate further.

COURSES IN UNDERWATER MEDICINE

No further dates are available for these courses conducted by the Royal Australian Navy. Applications to attend the September 1981 course exceeded the number of places available. The Royal Australian Navy makes the final selection of candidates.

GENERAL BUSINESS

The Secretary raised the topic of "Travel Subsidy" to attend Executive Committee Meeting. This concept hopefully will encourage greater participation in the Executive by members of the Society. Before any decision is made, this matter will be raised at the next AGM.

Nominations for the positions on the Executive are to be called for in the next issue (December quarter) of the Journal.

The Meeting closed at 1230 hours.

Christopher J Lourey
Secretary - SPUMS